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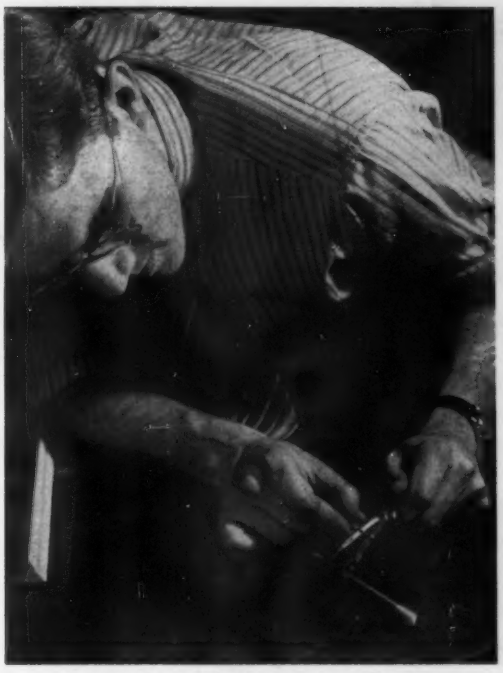

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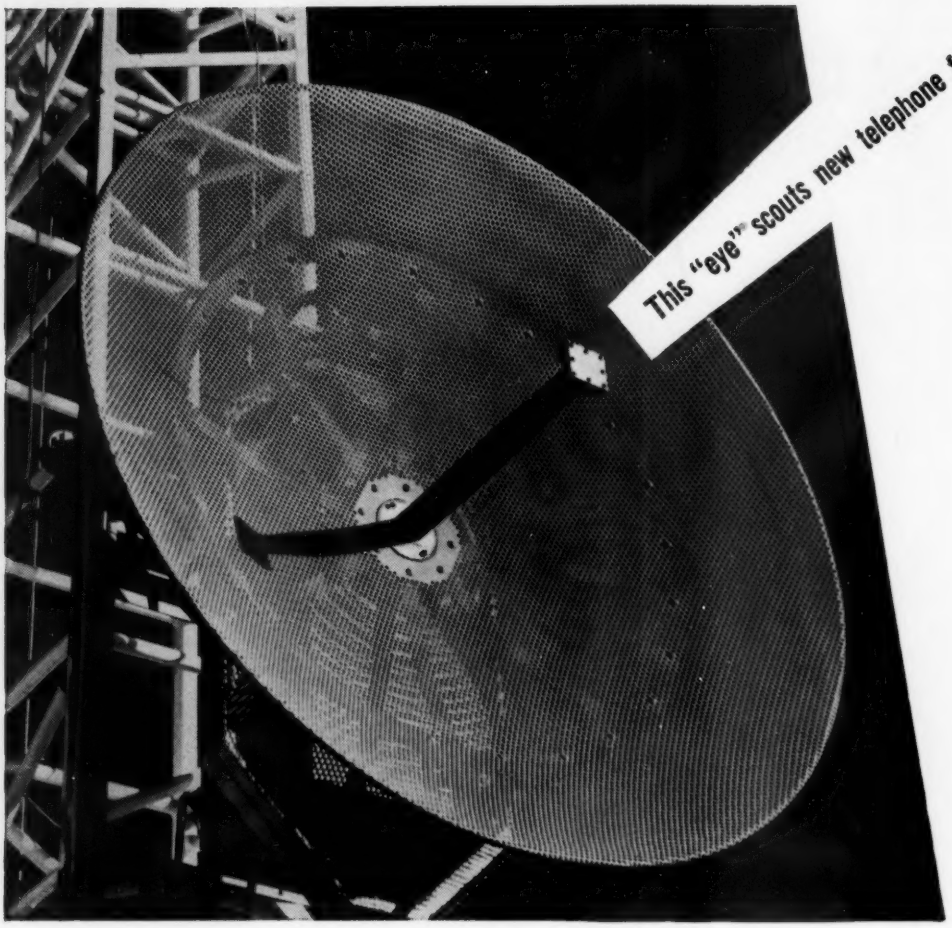

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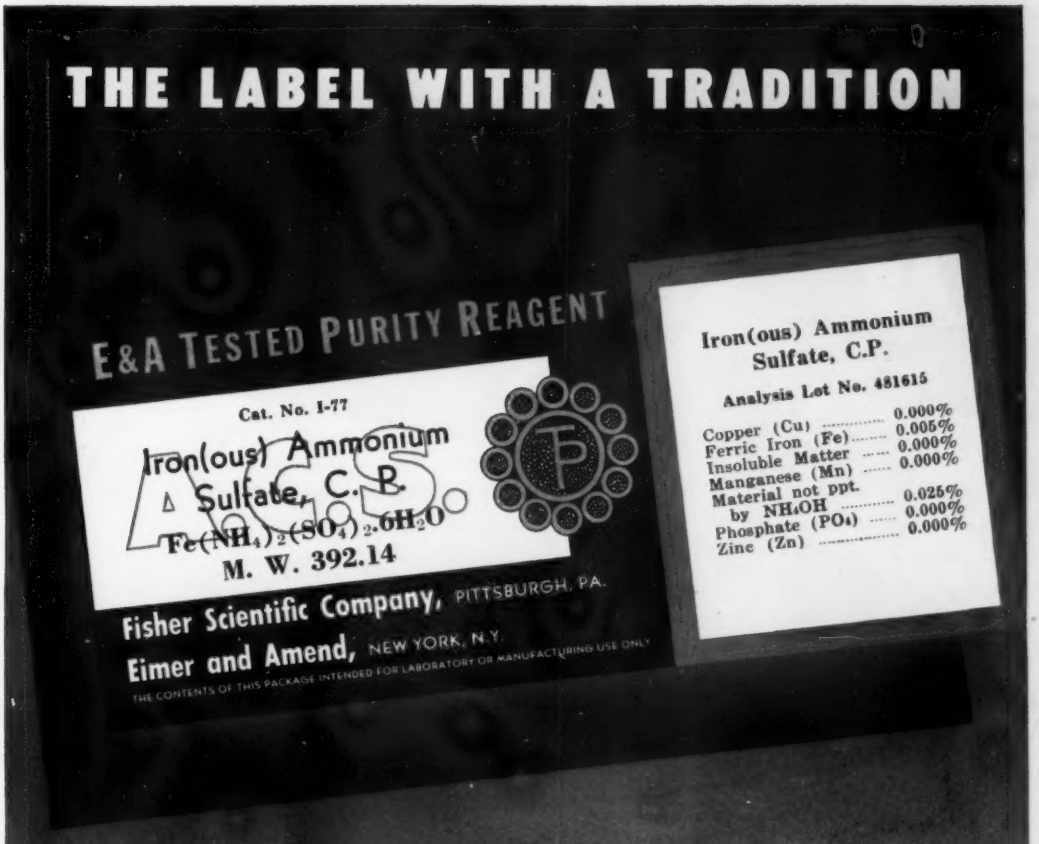
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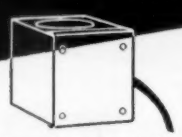

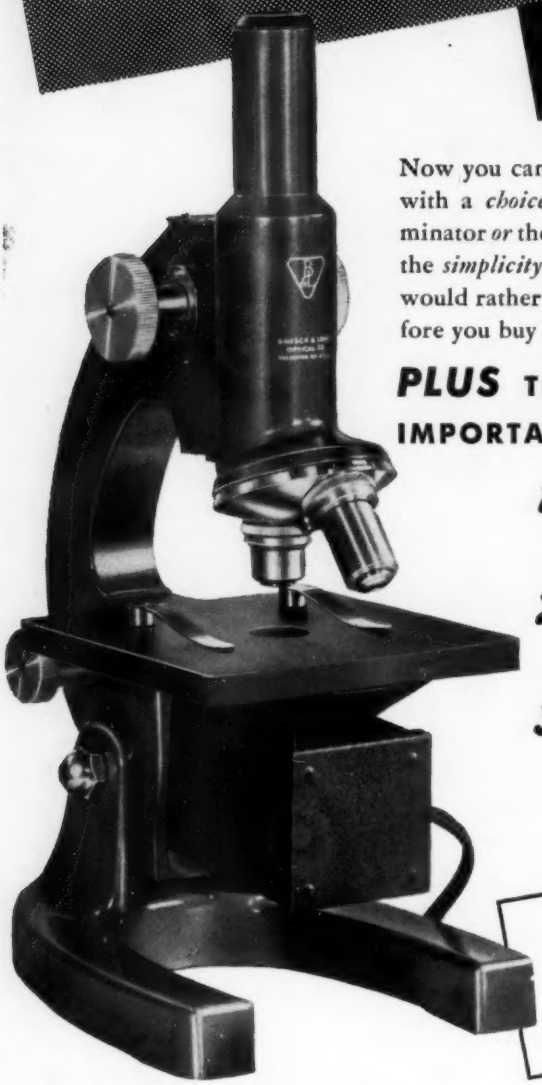

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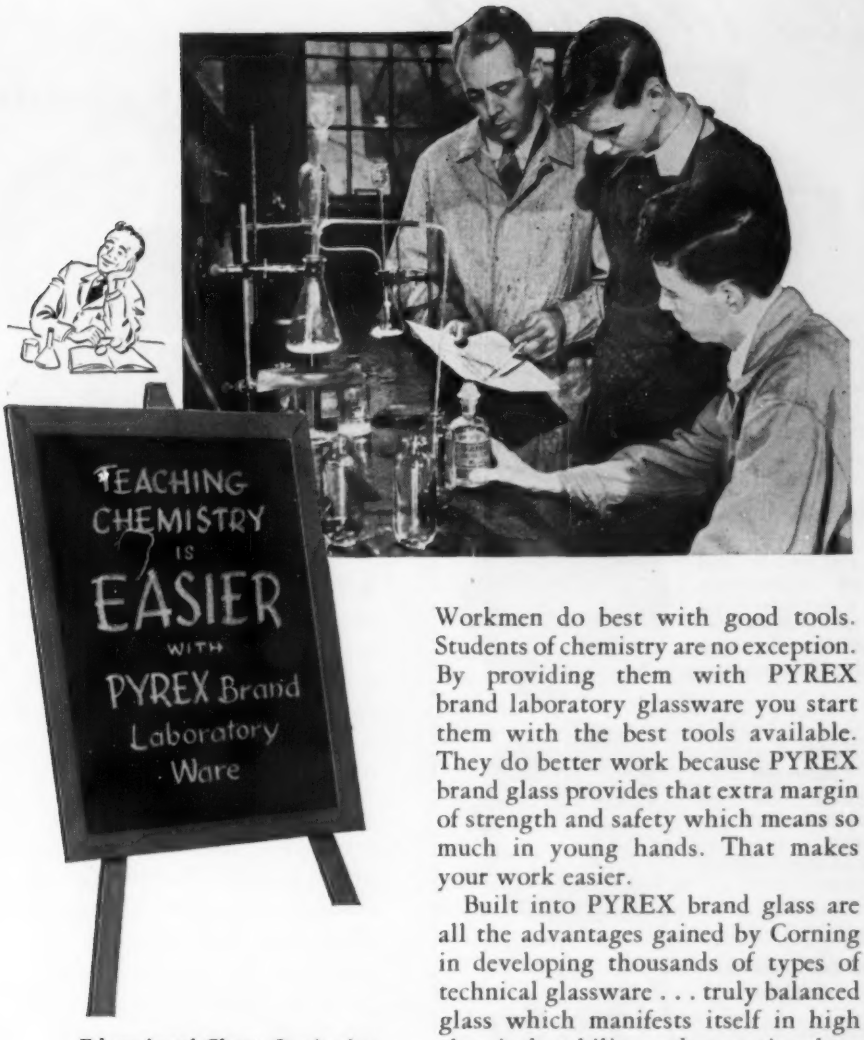

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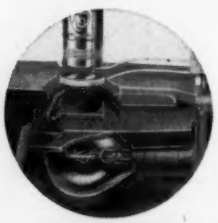

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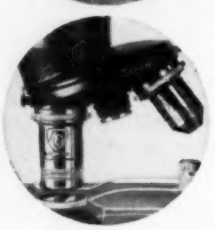

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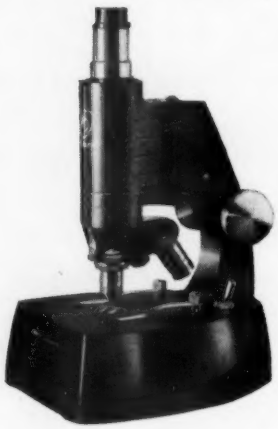

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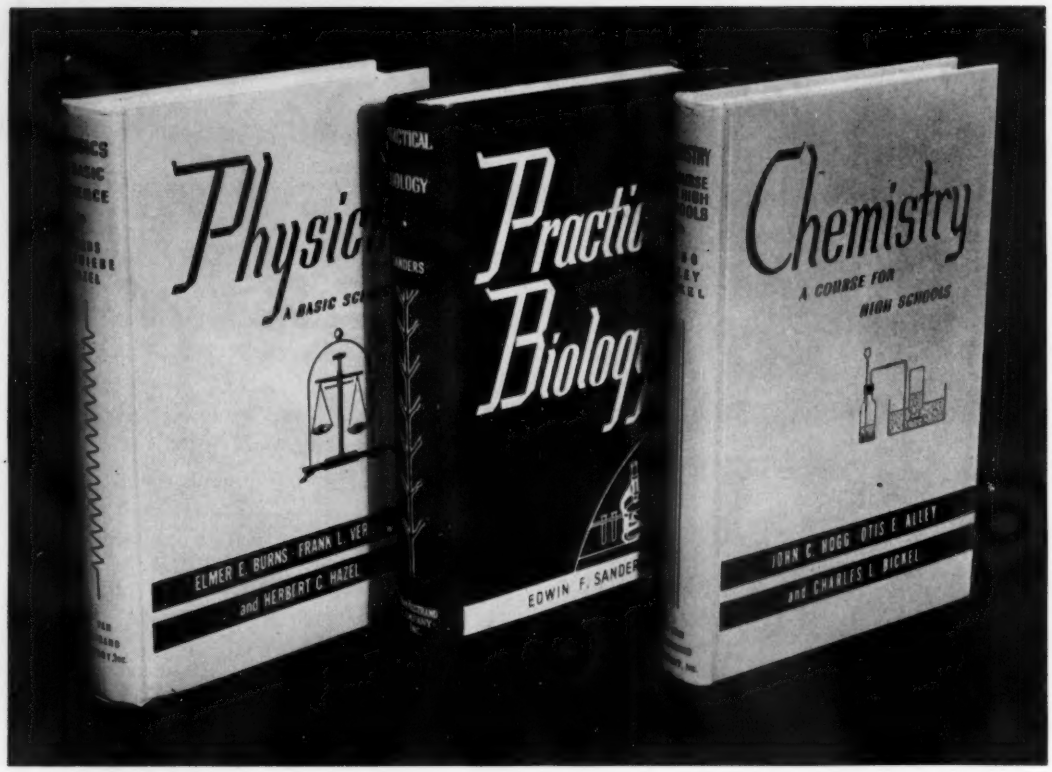

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VOLUME XVII APRIL, 1950 NUMBER 2

Individual Laboratory Work Must Be Retained

FRANCIS D. CURTIS

University of Michigan

AT THE turn of the century, it was generally accepted as a matter of course that all secondary-school pupils who took courses in science would do some individual laboratory work in connection with those courses. This practice and the philosophy that brought it about were the natural outcomes of the "scientific movement," which, reflecting college practices, had dominated secondary-school science during at least the preceding quarter century. The so-called "high-school movement," however, inevitably effected a change with respect to individual laboratory work. "The high-school movement" is the designation of the astoundingly rapid increase of high-school enrollments which began about 1892 and has continued with few marked decelerations to the present. Its impact upon the curriculum, student-body, and all other aspects of the secondary school can be appreciated from the fact that, on the average, one new public high school was built every day for at least thirty years, beginning about 1892.

The accelerating rate of increase in high-school enrollments during the first decade of this century imposed upon those responsible for the economical conduct of the high schools the increasingly serious problem of how to provide acceptable science training. In the mounting extremity, they desperately sought an acceptable substitute for individual laboratory work. They extended the already common practice of having pupils perform experiments in pairs; they increased the number working together to three, four or even more. But these measures failed to relieve the situation sufficiently. The substitution of lecture demonstrations for pupil experimenting seemed the only practicable way out of the predicament. If educators at both college and secondary levels could become convinced that in high-school science courses the lecture-demonstration method could be substituted without appreciable loss for the method by which pupils performed experiments individually, or even in pairs or groups, then the difficulty of providing adequate laboratory work would be happily solved.

This situation had become desperately acute at about the time when the educational research movement, in the modern meaning of that term, began. In the field of the teaching of science, this movement was ushered in by the learning study by Gilbert[1] and the curricular study by Trafton.[2] Inevitably the efforts of researchers would ere long be directed toward determining the relative merits of the individual and demonstration methods. It was not, however, until 1918 that Wiley[3] reported the first investigation of these two methods. During the next nine years, 13 studies of the relative values of the individual and demonstration methods were reported. With almost no exceptions the investigators interpreted their data as indicating, more or less conclusively, that the demonstration method effected at least as good learning as did the individual method.

THE accumulating evidence of the effectiveness of the demonstration method was hailed with enthusiasm by those educators who were eager to be convinced of its merits. Jubilantly they accepted these investigational results at par value. Since, they argued, the overwhelming evidence of so much *research* (not opinion, mind you, but *research*) clearly

1—J. P. Gilbert, "An Experiment on Methods of Teaching Zoology." *The Journal of Educational Psychology*, I (June, 1910), 321-332.

2—Gilbert K. Trafton, "Children's Interests in Nature Materials." *The Nature Stury Review*, IX (September 1913), 150-160.

3—William H. Wiley, "An Experimental Study of Methods of Teaching High School Chemistry." *The Journal of Educational Philosophy*, IX (April, 1918), 181-198.

reveals the equal, if not indeed superior, values of the demonstration method, why not substitute that method for individual pupil experimenting wherever it might be more convenient or otherwise desirable to do so? Evidence of the strength of this view is supplied by the fact that between 1925 and 1930, in at least two great cities, senior high schools were constructed which provided no rooms in which individual laboratory work could be carried on.

From the start, however, college and university teachers had vigorously opposed the trend toward the substantial reduction of individual laboratory work in senior-high-school courses. Moreover, even in the face of the supposedly overwhelming research evidence, considerable opposition was voiced by workers in the field of the teaching of science to this trend. Three evaluators[1] [2] [3] of this investigational evidence urged caution in accepting the conclusions of the investigators, by pointing out such considerations as the limited number of studies, the admittedly small numbers of subjects used in most of them, the inadequate statistical treatment employed, the general lack of adequate reporting of the techniques used and the aims of laboratory work to be achieved. Fortunately the meager evidence of positive values of the individual method reported in two early studies by Kiebler and Woody[4] and by Pruitt[5] was soon substantially reinforced by investigational results reported by Johnson,[6] and Horton.[7]

1—Elliot R. Downing, "A Comparison of the Lecture-demonstration and the Laboratory Methods of Instruction in Science." *The School Review*, XXXIII (November, 1925), 688-697.

2—R. A. Riedel, "What, if Anything, Has Really Been Proved As To The Relative Effectiveness of Demonstration and Laboratory Methods in Science?" *School Science and Mathematics*, XXVII (May, June, 1927), 512-519, 620-631.

3—Francis D. Curtis, "Some Reactions Regarding the Published Investigations in the Teaching of Science." *School Science and Mathematics*, XXVII (June, 1927), 634-641.

4—E. W. Kiebler and Clifford Woody, "The Individual Laboratory versus the Demonstration Method of Teaching Physics." *Journal of Educational Research*, VII (January, 1923), 50-58.

5—Clarence M. Pruitt, *An Experiment on the Relative Efficiency of Methods of Conducting Laboratory Work*. Master's Thesis (unpublished), University of Indiana, 1925.

6—Palmer O. Johnson, "A Comparison of the Lecture-demonstration, Group Laboratory Experimentation, and Individual Laboratory Experimentation Methods of Teaching High-school Biology." *Journal of Educational Research*, XVIII (September, 1928), 103-111.

7—Ralph E. Horton, *Measurable Outcomes of Individual Laboratory Work in High-school Chemistry*. New York: Teachers College, Columbia University, Bureau of Publications, 1928.

As head of the Department of Chemistry in the Seward Park High School, New York City, Horton was able to secure a sufficient number of equivalent groups for an indicative experiment. Then, too, he employed a more careful and scholarly statistical technique than those used in the early studies, and used a unique battery of tests measuring outcomes other than subject-matter knowledge, such as problem solving, self direction, and exercising judgment.

Horton's findings convincingly established real values of the individual method and effectively destroyed the assumed justification for its elimination. Accepting chiefly these findings, the Thirty-first Yearbook Committee, N.S.S.S. made its proposals[1] for the use of both demonstration and individual laboratory work, on the grounds that each of these methods supplements the other with unique and essential contributions.

THE battle to restore the individual method to its justified place, however, was not won. Two new factors effected further reductions in pupil experimentation. These were the economic depression of the nineteen hundred thirties and the developing trend toward confining science courses to only five periods per week.

The depression of the thirties imposed such a crippling financial handicap upon education that, in an appalling number of high schools, the demonstration method was substituted for individual laboratory work in part, if not altogether. Even in great city high schools, classes in biology, physics, and chemistry, in which as many as sixty pupils were enrolled, were given solely by lecture-demonstration such training as the harassed school authorities considered feasible in the existing crisis; and in general science classes, individual experimenting disappeared practically to the last vestige.

The trend away from the conventional seven-period program for biology, chemistry, and physics, that is, from three "recitation" periods and two double laboratory periods, toward that of five single periods per week, resulted from several influences, among them

1—*A Program for Science Teaching*. Thirty-first Yearbook N.S.S.E. Part I. Bloomington, Illinois: Public School Publishing Company, 1932. 101-102.

Continued on Page 82

President's Page — By Nathan A. Neal

IN THIS final Journal of the current school year it seems appropriate to express a thought on secondary school science textbooks.

In the ideal world implied by modern educational theory, textbooks would be only source materials. However, there is hardly any secondary school situation today in which textbooks do not determine to some slight extent what is taught. In the vast majority of school situations there is no influence which does more to determine what is taught to pupils. In an unhappy fringe of education the textbook is the sole factor in determining all that is taught. This situation has long held, and is little changed in general practice today.

From the evidence it would seem that textbooks are an important element of in-service teacher training. Almost all teachers are influenced to some extent by the teaching procedures suggested in textbook prefaces, chapter end teaching exercises, workbooks, laboratory manuals, printed subject matter tests, and teacher manuals to accompany textbooks. In a very large number of cases today the textbook and its accompanying publications constitute the most important source of in-service training in methods of teaching. Again in an unhappy fringe of present day practice it is the only source of continued in-service training. Since it is known that textbooks influence teaching procedures it may be argued that textbooks therefore should, to the extent possible, reflect the best of modern teaching theory.

But it is not in the field of method that textbooks exert their greatest influence. Textbooks shape the curriculum more often than educators, authors and publishers would have the case. It is not the purpose here to labor the point or suggest remedies. Rather, since textbooks do so often determine the nature of the curriculum in practice, let us make our textbooks, to the extent possible, in terms of the best modern curriculum theory.

But before attempting to suggest any relationship between textbooks and theory in science teaching, let's look at two brief quotations. The Forty-sixth Yearbook[1] states:

"The desirable procedure . . . is not to "get rid of the textbook" (because any textbook is likely to provide better materials than the average teacher can improvise or assemble in the time and with the facilities available) but to avoid restricting the study to the contents of a single textbook and, instead, to supplement it as abundantly as may be necessary. Such a procedure can, as effectively as any other, provide for the individual differences of pupils. Also, it possesses the important advantages of providing not only a foundation of minimal essentials common to all the class but also a definiteness of sequence and of continuity which a course based on miscellaneous reference materials rarely possesses."

In a very different sort of reference[2] we have the following:

"The one teaching implement so universally used as to be a social phenomenon of the first magnitude is taken almost too much for granted. Unlike other more recent teaching aids, textbooks have not had to prove themselves on sound scientific grounds. Until they are subjected to . . . carefully controlled experiments, we can only make guesses as to what a textbook really should be, how great a contribution it is capable of making, how it can best be used, how it should be judged."

WHAT, in fact, can be done to determine how abundantly a good textbook needs to be supplemented and how science textbooks in general should be judged? In extreme brevity, the answer would seem to be in the direction of examining science textbooks for the nature and extent of their functional approach. Functional approach in this case is intended to refer to broad areas in which most of the persistent problems of living occur. These functional areas include personal and community health, safety consciousness, occupational perspective, recreational opportunities, conservation mindedness, intelligent consumership, responsible economic action, and the inclusive area of objective think-

1—Forty-Sixth Yearbook, Part I, p. 48; National Society for the Study of Education, 1947.
2—"Textbooks in Education;" p. 8; American Textbook Publishers Institute, 1949.

Continued on Page 86

Membership News and Notes

By ROBERT H. CARLETON, Executive Secretary, NSTA

THE fact that Spring is a season for "house cleaning" has nothing whatsoever to do with the fact that it is also the time to vote on NSTA officers and directors for the ensuing year. The report of the Nominating Committee and the slate of nominees for 1950-51 will be mailed from NSTA headquarters about the third week in April. Ballots should be marked and returned to the Executive Secretary by May 10. Chairman of the Nominating Committee is Elmer Headlee, 221 East Argonne, Kirkwood 22, Missouri—in case members wish to comment or suggest for the future.

Proposed Changes in Dues

As announced in the February issue of *The Science Teacher* (page 34), NSTA members are also being asked to vote on a revised schedule of membership classes and annual dues. The proposed changes were recommended by the Board of Directors after careful study and an informal poll of members conducted last fall. The proposals represent a modest increase in dues for certain classes of membership, reductions in others. It should be pointed out that approval of the changes will still keep the cost of NSTA membership 25 per cent below the average of other departments and associations connected with NEA and tied for last place among those maintaining a national headquarters office and full-time staff.

Basis for the Board's recommendation is the expanding program of NSTA membership services, chief among which is the ownership and impending Association publication of *The Science Teacher*. Beginning with the October issue, for example, the Journal will be on a six-times-a-year schedule. Other projects developed by committees and approved by the Board of Directors are "in the mill" and will be announced in due time.

Industry-Science Teaching Relations

THE NSTA program of cooperation with industry and other non-educational groups continues to progress. The Atlantic City Regional Conference on Industry-Scienee Teaching Relations, held February 25, was hailed by attendants as "one of the very best" in the series of national and regional meetings sponsored by the NSTA Advisory Council. Representatives of about 60 organizations attended the conference. Following a presentation by Dr. Morris Meister of highlights on the report on *How Science Teachers Use Business-Sponsored Teaching Aids*, a "panel and counter-panel" discussed the findings and their implications. The "panel" representing industry included Dr. G. Edward Pendray, chairman, of Pendray and Leibert Public Relations Counsel, New York City; Mr. Gilbert P. O'Connell of the General Motors Corporation; Dr. Thomas J. Sinclair of the Association of American Railroads; Mr. Louis M. Stark of the Westinghouse Electric Corporation; and Mr. Robert E. Williams of the Standard Oil Company (N. J.). The "counter-panel" representing science teaching was made up of Mr. Robert H. Carleton, chairman; Professor Earl R. Glenn of Montclair (N. J.) State Teachers College; Dr. Philip G. Johnson of the U. S. Office of Education; Professor Ralph W. Lefler of Purdue University; and Mr. Elbert C. Weaver of Phillips Academy, Andover, Mass. Members of NSTA have been informed of highspots of the report in the descriptive brochure contained in Packet XIII.

An important symposium on "Next Steps for the Improvement of Business-Sponsored Teaching Aids" featured the afternoon session of the conference. An expert discussed each phase of the NSTA and Advisory Council program known as CEDUR—*C* for consultation, *E* for evaluation, *D* for distribution, *U* for utilization, and *R* for research. President Nathan A. Neal announced the NSTA Board of Directors' approval for the formation of a Business-Industry Section in the Association. First steps toward the organization of the Section were taken at a committee meeting held in New York City April 1, 1950. Members of the committee were Mr. G. P. O'Connell, chairman, Mr. Cyril Daldy of the Sun Oil Company, Mr. Louis M. Stark, Mr. Nathan

A. Neal, Dr. Morris Meister, and Mr. Robert H. Carleton.

Meanwhile the NSTA Packet Service, with the cooperation of many organizations, keeps rolling along. Packet XIII recently distributed marks the beginning of the fourth year of this activity. Plans for a large-scale distribution of a special Packet to some 25,000 science teachers next September are beginning to crystallize. To include a copy of the first NSTA issue of *The Science Teacher*, it is hoped to induce an additional 2,500 science teachers to join the Association and share in its program of activities and membership services.

Science Talent Search and Science Fairs

A RATHER large number of inquiries reaching us during the past few months concerning NSTA's role in science talent searches and science fairs prompts us to offer a few words of explanation. NSTA *does not* conduct or sponsor any science talent searches, nor does it conduct any science fairs. However, NSTA as an organization and many of our members individually have participated in a number of ways in such undertakings, such as endorsing science fairs, serving on planning committees or as judges, distributing literature in our Packets, and publishing articles about these projects in the pages of our Journal.

What is often referred to by inquirers as "the national science talent search" is sponsored by the Westinghouse Educational Foundation and is conducted by Science Clubs of America, Margaret Patterson, Executive Secretary. SCA also sponsors science fairs in many cities over the nation and this spring will conduct the first National Science Fair in Philadelphia, May 19-21, under the sponsorship of newspapers throughout the country. On the other hand, several organized efforts to locate and encourage students with science potential and several science fairs are conducted on a regional, state, or local basis apart from SCA.

Science Clubs of America is a part of Science Service, Watson Davis, Director, 1719 N Street, N. W., Washington 5, D. C. Both Mr. Davis and Miss Patterson are members of NSTA, and our respective offices are "just around the corner" from each other. This makes possible frequent consultation and cooperation on problems of mutual concern.

People

WE HAVE recently received three interesting pamphlets indicating that several NSTA people will spend part of their summer in special studies of conservation problems. Dr. Howard H. Michaud of Purdue University is Camp Director of the fifth annual Conservation Education Camp to be held June 26 to August 3 at Versailles, Indiana. Especially designed to meet the needs of teachers, school administrators, and others interested in leadership in conservation, there will be lectures, discussions, field trips, plot studies, and visual aids for presenting the best methods for teaching conservation of soils, water, minerals and plant and animal resources. The program is open to residents and non-residents of Indiana at low cost.

The New Jersey Conservation Education Workshop will be held at Trenton State Teachers College July 10-28. Director of the workshop is Dr. Victor L. Crowell. Restricted to residents of the state, the workshop will aim to provide information from first-hand observations concerning the extent of New Jersey's natural resources and their importance to all citizens; the need for conservation of resources; desirable conservation practices; and practical methods and materials useful for teaching conservation in the schools.

The Iowa Conservation Education Camp will operate for two 3-weeks periods beginning in June. Conservation education for the elementary school level will be emphasized. Directors of the camp are Dr. Gil Mouser and Dr. Dorothy Miller, both of State Teachers College, Cedar Falls, Iowa.

Howard Nelson, science teacher in the Glasgow, Montana, high school, really "hit the headlines in the January issue of *Montana Education*. The full-page cover photograph and more than four pages of pictures and text inside the magazine not only make interesting reading, but offer practical suggestions for making science teaching more stimulating.

ONE YEAR ago it was Dr. Jan Koning of Holland; this year it is Dr. Agvald Gjelsvik of Vinstra, Norway. Like his predecessor,

Continued on Page 86

Suggestions for Teaching Electronics

(Continued from February issue)

ROBERT STOLLBERG
Associate Professor of Science and Science Education
San Francisco State College

Making Electrical Connections

ONE of the outstanding obstacles to be overcome in developing this general kind of equipment was that of establishing the numerous electrical connections necessary among the many components involved in a typical circuit. The use of Fahnestock clips has been attempted, but there is little to recommend them except the economy. The problem here is that many electronics circuits require from two to several connections at a single point. This taxes the capacity of Fahnestock clips and greatly reduces the ease of use which characterizes this type of electrical fastener.

The system of electrical connections illustrated on these pages is based on a set of snap fasteners[2] shown in Fig. 6. There are three members of this family of connectors which may be described as follows:

lugs (Fig. 6, left)—designed to be screwed onto a surface or inserted into a binding post. Each unit bears a snap on one side of one end and a mounting hole in the other end.

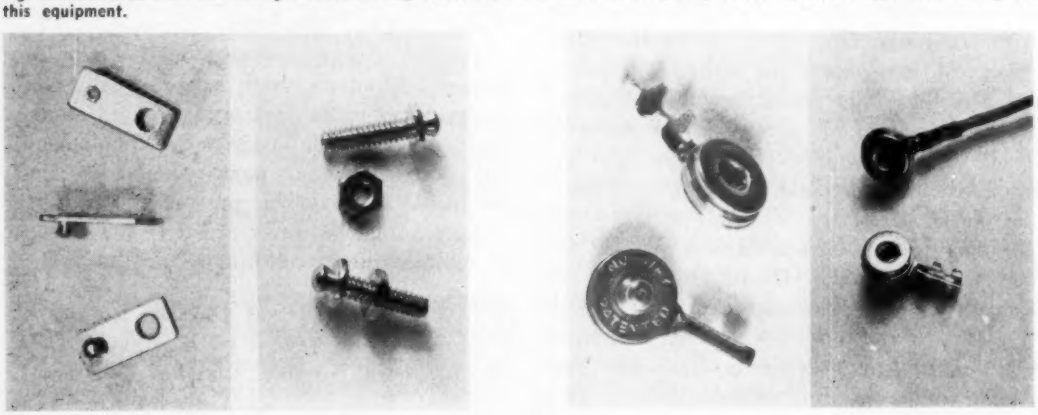
studs (Fig. 6, second from left)—designed to be screwed into a surface or through a hole in a thin panel or plate. Each unit bears a male snap on the end of and coaxial with a 6-32 machine screw, and is equipped with a corresponding hexagonal nut. The shoulder, immediately below the snap, is likewise hexagonal, permitting convenient insertion with pliers or socket wrench.

snaps (Fig. 6, right and second from right)—designed to be soldered to the ends of connecting wires. Each unit bears a male snap on one surface and a female snap on the other, thus permitting an almost indefinite piling up of connections at any one point, as illustrated in Fig. 7.

THE plaques illustrated in these photographs employ both lugs and studs, either of which is perfectly satisfactory. Lugs are readily installed on wood surfaces with a single wood screw. Studs may be fastened through a hole in a thin panel, or may be inserted into a 7/64 hole drilled in hard wood (smaller hole for soft wood), in which case they act in the manner of a self-tapping screw. The permanent electrical connections to either type of fastener can be made merely by inserting the bared end of a wire under it before the screw is tightened into place. Either studs or lugs

2—These units may be obtained from the Hatheway Manufacturing Company, New York Office, 43 West 24th Street, New York, N. Y., and also from Allied Radio Company, 833 West Jackson Blvd., Chicago, Ill., and other similar radio parts distributors. Prices vary from about three cents to nearly 6 cents per unit in quantities of 100 or more.

Fig. 6. Illustrated from left to right are male lug fasteners, male stud fasteners, snap fasteners, of the type used throughout this equipment.



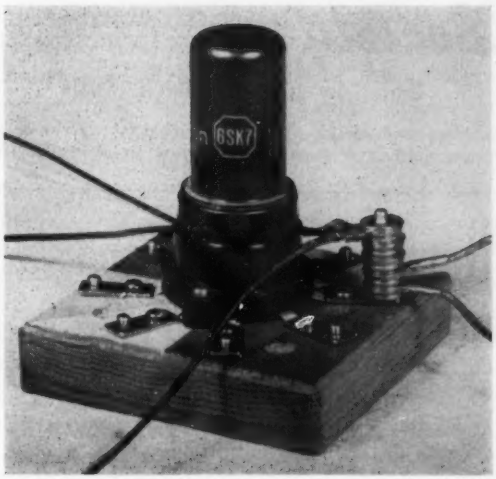


Fig. 7. Snap fasteners of the kind described in this article can be piled up in considerable numbers, thus permitting many connections to be made to a single point in a circuit.

can be used to replace (or supplement) the binding posts on commercially supplied meters and other test equipment, thus making it possible to equip an entire laboratory for this system of establishing electrical connections.

Connecting wires are made of No. 18 stranded push-back wire. Stranded wire is preferred because it permits greater flexibility and reduces the tendency for wire to break after repeated bending. Experience has shown the snap fasteners to be surprisingly durable; a year's hard use produced a mortality of only a few percent. An assortment of several different lengths of connecting wires should be prepared. Black insulation shows up well against the light panel surface, but the wires can be color coded if desired.

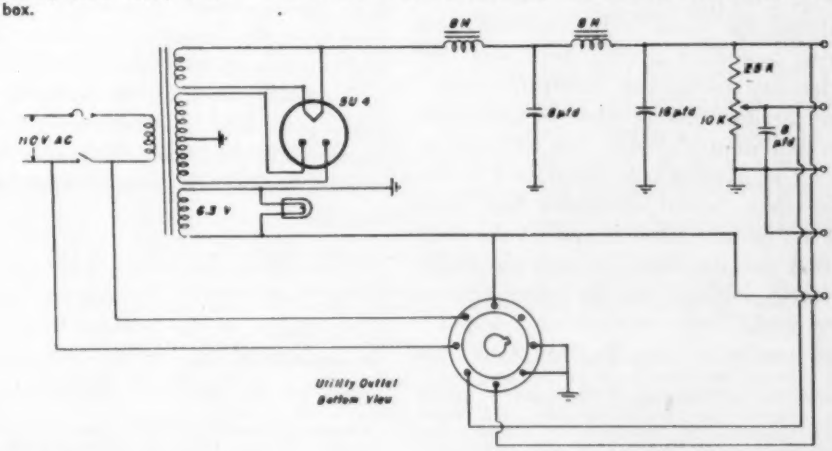
Providing Electrical Power for Circuit Operation

EXCEPT where power supplies themselves are the subject of study, it is most convenient to have a general utility power supply to provide the proper electric potentials to the circuit mounted on the panel. A practical circuit for a device of this kind is suggested in Fig. 8. The negative end of the high potential supply is grounded, as is one terminal (or center tap, if available) of the 6 volt ac filament supply. In addition, an adjustable tap supplying a medium high dc potential is provided to supply screen potentials or B-plus potentials for ac-dc circuits (typically about 100 volts). The terminals on this utility power supply can be snap connectors or some other kind of connections. The utility outlet for remote connection and control is optional.

In practice, the terminals of this utility power supply are connected to the assembly panel, which in turn is permanently wired for convenient distribution of the desired electric potentials. The arrangement shown in Fig. 1 has been found very useful. A pair of wires extends up one side of the panel, across the top, and down the other side. Equipped with several male connectors, this pair of buses is connected to the 6-volt ac terminals of the power supply. Across the bottom of the panel is another pair of buses, one red and one black (positive and negative, respectively),

Continued on Page 87

Fig. 8. This utility power supply circuit can be assembled from parts readily obtainable in a radio supply store or from a spare-parts box.



Science for Society

Edited by JOSEPH SINGERMAN

• A department in which science is presented in its close relationship to the individual and in which guidance is given in causing the individual to recognize the methods of science and its vast social implications.

The Interrelation of Human Heredity and Environment*

DR. BERNHARD J. STERN
Department of Sociology
Columbia University
New York City

ON THE eve of the mid-century it is especially appropriate to consider the shifting ground of the perennial heredity-environment in the perspective of the last fifty years.

The twentieth century began with the rediscovery of Mendel's work and the concomitant strident pronouncements by biologists that knowledge of human heredity had reached the level at which it was competent to determine public policy. Karl Pearson set the tone and established the pattern of this outlook. In his *National Life from the Standpoint of Science* published in 1901 he contended that: "The form of a man's head, his stature, his eye color, his temper, the very length of his life . . . these and other things are all inherited and in approximately the same manner" and urged that "if we once realize that this law of inheritance is as inevitable as the law of gravity, we shall cease to struggle against it." He spoke glibly and ominously of bad stock, presumed the superiority of the white race and wrote of the Kaffir and the Negro: "Educate and nurture them as you will, I do not believe you will succeed in modifying the stock." He equated class status with biological ability, bemoaned decreased fertility among the "superior stocks," and large families among what he called the "reckless and improvident." His attitude toward social legislation was epitomized in the contention that "social sympathy and state aid must not be carried so far within the community that the intellectually and physically weaker stocks multiply at the same rate as the better stocks."[1]

At the same time that Pearson took this stand, there was controvening sociological, anthropological and Marxist literature as represented, for example, by Lester F. Ward, Edward B. Tylor and the socialists. There were alternatives to choose from. There is little doubt, however, but that genetics was born and nurtured in the soil of social Darwinian doctrine and in turn fertilized it. The doctrines of the continuity of the germ plasm, the theory of unit characters, and the penchant of geneticists to publish over-simplified genealogical charts illustrating Mendelian principles, all contributed to a distortion and exaggeration of the importance of the role of heredity. Moreover, what geneticists may have felt in the secret recesses of their hearts, or whatever misgivings they may have confided to friends, an unfortunately long time passed before geneticists of prominence publicly disassociated themselves and their science from the exaggerated claims of eugenics. and denounced the manner in which eugenics had latched itself on to genetics. The Carnegie Institution of Genetics at Cold Springs Harbor long continued to finance and publish widely quoted documents abetting eugenic doctrine.

THE trend against eugenics became evident in the late 1920's.[2] It was as late as 1935, when Muller in the preface to a book based on several of his earlier lectures declared: "Eugenics in the sense that most of us now

*Address before the joint meeting of Philosophy of Science Association, American Philosophical Association, and Section L, American Association for Advancement of Science, Hotel New Yorker, December 30, 1949, 8 p. m.

1—Pearson, Karl, *National Life from the Standpoint of Science*. (London, 1901) p. 15-54.

accustomed to thinking of it, has become a hopelessly perverted movement. Beyond imposing some slight limitation on the numbers of the grossly defective, *it would be, with its present methods and outlook, powerless to* work any positive changes for the good. On the other hand, it does incalculable harm by lending a false appearance of scientific basis to advocates of race and class prejudice, defenders of vested interests of church and state, Fascists, Hitlerites and reactionaries generally. Even the least unreasonable of the professional spokesmen of this modern Eugenics have taken no clear stand against the atrocities recently proposed and carried out in its name."[2]

Muller's vigorous rejection of eugenics[4] was itself restricted to its gross manifestations. He offered in its place a romantic proposal that after the social and material environment had been made favorable for the development of the latent powers of men in general, it would be possible by artificial insemination to breed "comradeliness" and "intelligence" which "when active and well organized, issue in the 'co-operation' and 'knowledge' by which mankind has advanced." Acknowledgement was made that "Each of these two traits is of course the resultant of a complex system of more elementary factors, and the development of each is simply responsive to environmental influences as well as affected by genes." But Muller contended that after the weight of economic and social oppression had been removed there would be "fair means of recognizing most of the individuals in whom an exceptional concentration of such desirable genes lies."[5]

ANY contemporary linking of genetics and eugenics might, perhaps, be thought of as unwonted stirring up of dead embers, the flaying of ghosts of the youthful, groping neo-Mendelism of the past. Genetics has repudiated its early blunder of the concept of unit characters, and recognized the complexity of inheritance in man. There is much frank criticism of its previous position as "crude and naive."[6] The role of selective agents in causing genetic changes in human heredity are now known to be small. Genetics at present holds that "no statement about genetic difference has any scientific meaning unless it includes or implies a specification of the environment in which it manifests itself in a particular manner."[7] Jennings' 1935 formulation is now generally accepted that "characteristics do not fall into two classes, one exclusively hereditary (or dependent on genes), the other exclusively environmental; that every characteristic is affected both by the materials of which the organism is composed, and by the effects of the environmental conditions on these materials, and that some characteristics are more readily altered by these conditions than others."[8] Much of the assurance that geneticists know enough to dictate public policy has disappeared, for they are busy restructuring the very foundations of their concepts of the nature of the gene, and its relation to hereditary and growth processes.

Yet because of the reluctance of geneticists to relinquish entirely the hope for human genetic engineering the linkage of genetics to eugenics is still a real one. Some widely used college genetics textbooks continue to publish chapters on eugenics repeating traditional eugenic doctrines with minor qualifications.[9]

The most recent evidence that the issue is not a dead one, and that eugenics has a tenacious and pernicious hold on genetics is given in Curt Stern's 1949 book, *Principles of Human Genetics*,[10] one chapter of which, that on "Selection and Eugenics," was given wide circulation by its publication in preliminary and slightly contracted form in *Science*.[11] I have selected Curt Stern's discussion for criticism not because his is the most grievous, but because he is a geneticist of stature whose

2—Eg. Jennings, H. S., *Prometheus, or Biology and the Advancement of Man.* (New York, 1927)

3—Muller, H. J., *Out of the Night: A Biologist's View of the Future.* (New York, 1935) pp. ix-x.

4—It is noteworthy that this utterance was not hailed or given support by geneticists and others accorded his more recent polemics against Lysenko.

The review in the *Journal of Heredity*, 27 (1936), which was captioned "Communist Eugenics" and was largely an abstract of the book's contents, declared in its opening paragraph that "some parts may be read with safety even by a man with a weak heart." Popenoe and Johnson's *Applied Eugenics* had received a favorable, uncritical review in the previous volume.

5—Muller, *op. cit.*, pp. 118-120.

6—Muller, H. J., C. C. Little and L. H. Snyder, *Genetics, Medicine and Man.* (Ithaca, New York, 1947) p. 20.

7—Hogben, Lancelot, *Nature and Nurture.* (London, 1933) p. 14.

8—Jennings, H. S., *Genetics.* (New York, 1935) p. 232-265.

9—Eg. Snyder, L. H., *Principles of Heredity.* 3rd ed. (Bost. Heath, 1946) Colin, E. C., *Elements of Genetics.* 2nd ed. (Phila., Blakeston, 1946)

10—Stern, Curt, *Principles of Human Genetics.* (San Francisco, Cal., 1949) pp. 506-541.

judgment is likely to have wide influence. He has incorporated in his analysis some of the well established criticisms of eugenics. But in his discussion of the eugenic thesis that the intellectual genetic endowment of Western populations is in danger of decreasing because of differential fertility along class lines, he manifests conventional biases and pitches the authority of his science on the side of eugenic doctrine. He begins by acknowledging that "it is not possible, at the present time, to state with certainty whether different socioeconomic groups are genetically differentiated" (p. 514). However, when interpreting the divergent I. Q. scores of "own" and foster children grouped by occupational categories, he nevertheless contends that "it is hard to avoid the conclusion . . . that there *are* mean differences in the genetic endowment of the different socioeconomic groups" (p. 515). (Italics are in the original.) He makes repeated qualifications as he proceeds, but his discussion concludes that "it is likely that the present differential fertility of the different socioeconomic groups has a dysgenic effect in regard to intelligence" (p. 520).

BEFORE pronouncing a crucial judgment of such great importance which has potential influence upon social and educational policy one would hope that the author would be careful to utilize only the most reliable data. The very contrary is true. Leahy's 1935 study of the comparison of I. Q.'s of "own" and foster children in homes of different occupational categories is selected from other like studies analyzed in Osborn's *Preface to Eugenics* published in 1940, but Osborn's recognition that the study has limited applicability "in view of the small number of persons included in the present studies and the many weaknesses of the studies themselves,"[12] is ignored. Similarly, the table presenting the findings of Goodenough's study in 1928 of the I. Q.'s of 380 preschool children correlated with the occupation of their fathers is a fragment of a larger table derived from Osborn, but Curt Stern has paid no attention to the footnote warning in Osborn's table that testing for preschool children "is not so valid as for the school years."[13] Curt Stern evidently felt that his case would be stronger if he showed that his generalization applied to the Soviet Union as well as to the United States. In his preliminary publication of the chapter in Science he used data derived from intelligence tests given in Charkov in 1929.[14] However, in the book he abandoned these data as unsatisfactory and used in their place a table showing correlation coefficients between mental test scores of infants, and the earnings of fathers in Kazan in 1938,[15] not realizing that infant mental tests used at that time were in the experimental stage and were of doubful value. This is the sum total of his proof for the likelihood that the present differential fertility of different socioeconomic groups "has a dysgenic effect in regard to intelligence."

Curt Stern's basic error, and one that is characteristic of many geneticists, is to give credence to intelligence tests modeled after the Binet tests as instruments for establishing genetic differences. It is not enough for him to make qualifying comments such as "Psychological tests which measure mental differences are imperfect indicators of the genetic nature of such differences, since psychologists have not yet fully succeeded in devising tests which are equally intelligible to individuals who have grown up in different social surroundings (p. 515)," and then to proceed to declare that "Yet even with these imperfections of the tests in mind, the results . . . strongly suggest hereditary influence." This might have been excusable in 1940 when Osborn wrote *Preface to Eugenics* although such a contention is debatable. But recent detailed investigation on what is measured by intelligence tests in use by Davis, Havighurst and their co-workers[16] have proven unequivocally that the differential scores of persons when classified according to the occupations of their parents are explicable entirely in terms of the nature of the tests themselves. These studies render spurious any surmises about genes of intelligence determining the scores of conventional intelligence tests and negate any further use of I. Q. scores by geneticists as is done by Curt Stern and many others."[17]

11—Stern, Curt, "Selection and Eugenics," *Science*, 110 (1949) pp. 201-208.
12—Osborn, Frederick, *Preface to Eugenics*. (New York, 1940) p. 66.
13—Osborn, *Op. cit.* p. 82.

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Hydrogen Chloride and Hydrochloric Acid

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HYDROCHLORIC acid is one of the major heavy chemicals with a wide variety of markets. Great tonnages are consumed in pickling of metals for scale removal, cane-sugar refining, synthetic-rubber production as well as the production of glucose from corn starch. It is used in large quantities in the petroleum-producing areas for activating oil wells. Other applications include glue production, manufacture of chemicals, leather-processing, manufacture of rayon and dyes, reclaiming rubber, production of fatty acids and many other chemical-process operations.

At the present time, hydrochloric acid is produced by four different methods in the United States: (1) Sodium chloride is reacted with sulfuric acid at high temperatures to produce hydrogen chloride gas and sodium sulfate (salt cake, Na_2SO_4. (2) One producer in Louisiana still uses the Hargreaves process in which sulfur dioxide, air, and some steam are passed upward through layers of salt in vertical chambers.

$$4NaCl + 2SO_2 + 2H_2 + O_2 \rightarrow 2Na_2SO_4 + 4HCl$$

(3) Since 1920, increasing use has been made of direct synthesis of hydrogen chloride from hydrogen and chlorine gases. The result is a higher quality product at increased cost. (4) In recent years a large expansion in the chlorination of hydrocarbons has resulted in an abundant supply of hydrogen chloride as a by-product. In 1948 perhaps one half of all the hydrochloric acid used was obtained as a by-product from such chlorinations. During this period, concentrated hydrochloric acid, 20° Bé (31 percent HCl) sold for twenty dollars a ton.

WE ARE all familiar with the fact that hydrogen chloride is liberated readily by the action of concentrated sulfuric acid on common salt, accompanied by much frothing. The first reaction at low temperatures (below red heat) is that of sulfuric acid acting as a monobasic acid.

$$NaCl + HHSO_4 \rightarrow NaHSO_4 + HCl$$

The reaction goes to completion because a gas escapes. The boiling point of hydrogen chloride (-83.7°C) is far below that of sulfuric acid (338°C for the 98 percent acid). At temperatures above red heat, the second reaction proceeds, yielding sodium sulfate and more hydrogen chloride.

$$NaCl + NaHSO_4 \rightarrow HCl + Na_2SO_4$$

Thus, the reaction that is commonly represented as

$$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$$

involves two clean-cut steps and distinct crystals of either sodium hydrogen sulfate or of disodium sulfate may be formed, depending upon the temperature.

When a mixture of hydrogen and chlorine in proper proportions is exposed to light of suitable wave length and intensity, a violent explosion occurs. Hydrogen chloride is the product and the photochemical synthesis has been shown conclusively to be chain reaction. In this process a molecule of chlorine is decomposed into atoms of chlorine by light energy of suitable wave-length. One of the free atoms of chlorine is activated or is somewhat more energetic than its neighbor (its electrons are moving at a higher energy level or moving in an orbit of excitation) and is represented as Cl*

$$Cl_2 + hN \rightarrow Cl^* + Cl \quad (hN = \text{a photon of light energy of frequency } N)$$

The activated chlorine atom then reacts with a hydrogen molecule.

$$Cl^* + H_2 \rightarrow HCl + H^*$$

forming a molecule of hydrogen chloride and an activated atom of hydrogen. The activated atom of hydrogen in turn reacts with a chlorine molecule.

$$H^* + Cl_2 \rightarrow HCl + Cl^*$$

The cycle is now complete and ready to start again. Other photons of light energy start more chains and an extremely rapid combination results. This cycle can be interrupted by the presence of foreign materials, *inhibitors*,

that react with the activated atoms and thus block the propagation of the chains.

THE BOND joining hydrogen to chlorine in hydrogen chloride is generally considered to be a covalent type union, consisting of a single electron pair. The combining number (or valence) of each element is one, corresponding to a contribution of one electron each to the shared pair. An electron from the chlorine atom now lies in the K shell of the hydrogen atom, completing its stable group of two. Simultaneously, an electron from the hydrogen atom is likewise in the outermost L shell of the chlorine atom, forming a stable group of eight. We may represent the situation by the following diagram: H:$\dot{\underset{\cdot\cdot}{\text{Cl}}}$:

According to Dr. Pauling,[1] however, there is a tendency for the molecule to be somewhat ionized, about 20 per cent, which gives the hydrogen end of the molecule a small positive charge and the chlorine end a small negative charge. Thus in discussing structures of compounds it is not always possible to say categorically that compounds are either ionic or covalent, since polar compounds like HCl may exhibit properties related to both types of structures.

A consideration of the relative sizes of the particles helps clarify the picture. The radius of the nucleus of the hydrogen atom, a proton, is 10^{-13} cm and that of the kernel of the chlorine atom is 10^{-8} cm. Hence if we consider the atoms as spherical in general shape, a molecule of hydrogen chloride resembles a large balloon with a ping-pong ball attached to it. Since the compound is considered to be polar, presumably the electron pair is closer to the chlorine end of the molecule than to the hydrogen end.

Our students may want to know why the compound shows such an attraction for water that it fumes in moist air, why it is so reactive chemically and yet so stable that it can be heated to a high temperature without decomposition, and why a substance that seems so mild in the gastric juice of the stomach becomes so vigorously reactive when concentrated. These properties must be explained on the basis of the structure of the HCl molecule and the ways in which it reacts with other molecules.

THE low boiling point of hydrogen chloride (−83.7°C) indicates that HCl molecules do not have a very great attraction for each other. On the other hand, dilute or 6N hydrochloric acid (20.2 percent HCl) at 760 mm, boils at 108.6°C, 8.6° above the boiling point of pure water. Hence we may conclude that HCl molecules have a relatively strong attraction for water molecules.

While 44,200 ml of HCl dissolve in 100 ml of water at room temperature, the process of dissolving is complicated by its high heat of absorption, 13,600 calories per mole of HCl in 35 percent acid. Thus about 0.7 the heat of evaporation of water is evolved when absorption is started with water at room temperature. The absorbing solution soon begins to boil and absorption slows down and stops when the concentration reaches 14.5 percent HCl by weight.

To handle the absorption of HCl industrially, inert equipment is used. This may be built of Karbate (impervious graphite) or metallic tantalum. For special purposes equipment may be built of palladium, platinum, Pyrex glass, fused silica, austenitic stainless steel (29 percent Ni, 20 percent Cr, 1.75 percent Mo, 3.5 percent Cu, no more than 1.0 percent Si or 0.07 percent C) or nickel or nickel alloys such as Monel metal. Commercial silicones are exceptionally resistant to aqueous hydrochloric acid and may be used for gaskets, lubricants, and coatings.

The solubility of hydrogen chloride in water on a weight basis is 82.3 g per 100 g of water at 0° C, and 56.1 g per 100 g of water at 60°C. It also dissolves slightly in ether and benzene and 327 ml in 100 ml of ethyl alcohol. Liquid HCl freezes at −112°C. The density of the gas is 1.64 per l at S T P and that of the liquid 1.194 g per ml at −86°C.

THE accepted explanation for the vigorous chemical reactions of aqueous hydrochloric acid is that a chemical reaction occurs when hydrogen chloride dissolves in water. That is, in the process of forming a solution, hydration of the proton, or hydrogen ion,

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1—Linus Pauling, GENERAL CHEMISTRY, W. H. Freeman and Company, San Francisco, 1947, p. 159.

Audio-Visual Aids

Edited by CHARLES R. CRAKES

The editor of this department will attempt to bring before the readers of this publication the latest articles written by science teachers who are making effective use of various forms of audio-visual teaching materials. He will also endeavor to present a cross-section of educational opinions on audio-visual aids he may gather in travelling about North America.

This article, written by Dorothy E. Justman, Audio-Visual Consultant for Justman Enterprises, 4204 La Branch, Houston, Texas, concerns the true experiences of talented youngsters of grade-school age interested in Junior High School Science, who attended *Educational Playhouse* last summer. (1949).

Educational Playhouse is a summer institution designed to supplement the regular school curriculum with orientation courses in cultural subjects through the integration of pertinent Audio-Visual Materials. The motto is "Education Through Recreation" with a policy of "No Report Cards," "No Homework," and "No Credit." It is understood that this is the only school of its kind in the United States, and the staff would be interested in information about any similar institution of which the readers of this magazine are aware.

Mrs. Justman received her B. A. Degree and Teachers' Certificate from the University of Houston in 1936, and immediately turned her attention to Audio Visual Aids. As Director of the Southmore Kindergarten, she took movies and photographs of the children at school, and began work on a Directory of Audio Visual Materials. During the war, she was in charge of the Central Audio Visual Education Laboratory of the Houston Independent School District and taught Audio Visual courses at the University of Houston for a short time.

Dorothy E. Justman

In 1947, Mr. and Mrs. Justman combined forces in a husband-wife team to establish JUSTMAN ENTERPRISES, specializing in Audio Visual Sales & Service.

Science Can Be Fun

DOROTHY E. JUSTMAN

Houston, Texas

The characteristics of the atom raise a question about its very nature. Can the atom, with all its special qualities, be nothing more than a simple, solid particle like a tiny billiard ball? These pictures I've drawn show us the atom is made of even smaller particles.

In an electrified tube filled with hydrogen, atoms break apart into light negatively charged particles and heavier positively charged masses. The light particles are called electrons, the heavier ones, protons.

Since these two particles can be found in the atoms of all elements, they must be basic

units of atomic structure.

The hydrogen atom, which is the simplest of all, consists of a proton and a single electron held together by the attraction of their opposite electrical charges. The proton being heavier, acts as a central core or nucleus, while the almost weightless electron circles at a distance.

The total volume of the atom is mostly empty space. All atoms regardless of weight or make-up are constructed in this general way. In all of them the nucleus is a tiny compact mass surrounded by widely scattered electrons.

The helium atom has a nucleus of two protons plus two neutrons. Two electrons circle at some distance from the nucleus.

The lithium atom has three electrons, but the arrangement is different; i. e., the third is larger than the other two.

The reason for this is that only a specific number of electrons can circle at any one distance from the nucleus. Only two circle in the innermost "shell"—eight in the second —and so forth. In this way, shell after shell of the electrons is completed until in *uranium* —the most complicated atom found in nature, there are 92 electrons arranged in seven shells around a nucleus of 92 protons and 146 neutrons.

"Thank you," and, blushing, Master Robert Martin, aged 9, one week out of the High Fourth Grade sat down among his classmates in the science class at the Closing Exercises of Educational Playhouse. Not "quiz kids," but a selected group of children all with high "IQ's," who had spent three hours a week preparing themselves for Junior high school science, these youngsters amazed their parents at the way they grasped the facts of elementary science and presented them by means of short original talks illustrated with art work also designed by themselves.

Closing Exercises of Educational Playhouse

Bob smiled now, wearing an air of self-satisfaction. Listening to the other speakers, he thought back to his first day at Educational Playhouse . . .

Bob dug his fists into his pockets and stared hard at the floor . . . he hoped it would be worth his money . . . he had earned that money the hard way . . . but he wanted to study science and this way was one way . . . everybody else always said he was too young.

Actual Participation

Looking up . . . he thought he heard a familiar bicycle horn . . . sure enough, there were Vick and Charles. Maybe this *was* going to be O. K.

"Hi, there, Bob. We missed you last time. Let's go see the goldfish. Do you know we're to siphon water out of the bowl and clean it this time?

"I'll do it. Hand me that rubber tube, Charles. Don't suck on it, Vick. You'll—there—I told you . . . You got a mouthful of slimy water, didn't you? Well, if you didn't, you're lucky. Here, fill the tube with water, and see how it runs down into the pitcher.

Motion Pictures

"Say, Bob, did you know we're to see 'Jungle Marauder'—a film about a tiger and a snake fight. Look at these posters. Bet the tiger wins. There's the bell—race you to the fountain—I'm going to be on the front row to see that film.

Art Work

"Boy, what a picture . . . That 'Stray Lamb' wasn't bad either. I'm going outside to get a look at the bulletin board again, and then I think I'll make my poster.

Models

"I'm going to plan my poster from these

clay models of animals.

"I'm going to plan mine from real life—look at that cute little squirrel eating nuts.

Quizzes

"Here come our quizzes. Hope I'm through first, so I get to be on the Junior Forum.

"Look at the drawings, Bob. A butterfly and a horse for today.

"Hey, do insects have six legs?

"I think so, but we caught a grasshopper today. He's an insect. Let's go look at him.

Junior Forum

"Bob got all the answers right, and he was the first one through, so I guess he'll be the chairman for the Junior Forum today.

Recordings

"I was chairman last week, and we got to hear the recording of the Junior Forum on 'Botany' first, don't we?

Review

"Before we go inside, I want to see how the zinnia I transplanted last week is doing. Look, it has turned toward the sun. Zinnias like sun, I guess. Like most plants they need sunlight to produce chlorophyl. Remember that beautiful film, 'The Gift of Green' that we saw last week—about the process of photosynthesis of plants?

2 x 2 Slides

"It says on the bulletin board that after the Forum, Ruth will show us a slide-film —'How Color Protects Animals.'

Records

"Frances says she is to play the record—'Friends of Wildlife.'

Books

"After that it will be time to go home and we can choose books on botany or zoology to take home.

"Can't we take home books on physics, if we want to?

"Sure, because we'll study that next time, and, just think, we can keep them for a whole week just like we do at the public library. There's the bell—guess the Forum is ready."

There *was* the bell . . . Bob realized that the program was over as the little boys of the reading readiness class noisily struck their toy bells in the Circus Parade around the auditorium. He must have been day-dreaming with his eyes open. Everyone was receiving his certificate, and the science class was at attention ready to be called to the front in a body to receive their certificates of award for merit. This summer had been well spent, felt Bob, as he thought how proud his mother and daddy would be of his accomplishment. Not everything is in books, he had learned for one thing. Because . . . there were "sermons in stones," i. e., real life participation, motion pictures, models, art work, quizzes, forums, recordings, 2 x 2 slides, reviews, records, and books or audio-visual aids—both the newest and the oldest aids to learning. Even the Egyptians had their picture hierglyphics.

MATERIALS AVAILABLE AT THE 1949 EDUCATIONAL PLAYHOUSE

BOOKS

THE BASIC SCIENCE EDUCATION SERIES—Row, Peterson & Co., Evanston, Ill.
- Animals and Their Young
- Plants Round the Year
- Animals Round the Year
- How the Sun Helps Us
- Useful Plants and Animals
- Birds in the Big Woods

BLACK BEAUTY—McLoughlin Bros. Pub. Co.

JUST HORSES—Dombrowski.

JUST SO STORIES—Doubleday Doran Pub. Co.

STRANGE INSECTS & THEIR STORIES—Verrill.

ELEMENTARY SCIENCE BY GRADES—Teachers' College, Columbia U.

PATHWAYS IN SCIENCE

EASY EXPERIMENTS IN ELEMENTARY SCIENCE—Oxford University Press.

RECORDS (*Free)

*SLAUGHTER OF THE INNOCENTS—FREC (Federal Radio Education Commission) 33 1/3 rpm

*FRIENDS OF WILDLIFE—FREC

*WILDLIFE & RECREATION—FREC

*HUNTERS INTO THE UNKNOWN—FREC

*HAVENS OF REFUGE—FREC

*WATCH OUT—FREC

*FURS FOR AMERICA—FREC

*MYSTERIES OF MIGRATION—FREC

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Biological Applications of Supersonics

PROFESSOR W. J. FRY
Department of Electrical Engineering
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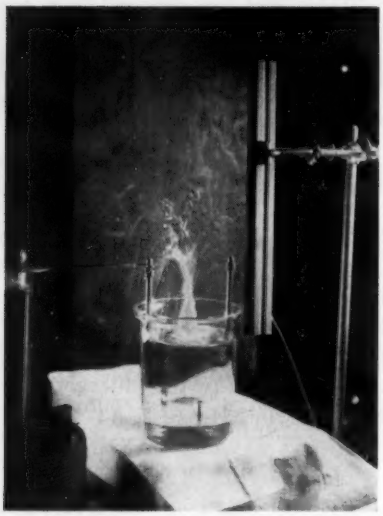

Fig. 1. This fountain of oil was produced by vibrating piezo-electric crystal.

THE GREAT opera singer, Caruso—if we can believe a much repeated story—was able to shatter a wine glass by singing a single note to it. Similar tales about the little recognized power of sound energy have gone the rounds from time to time but always in the cloak of a mystifying parlor trick rather than scientific achievement.

Since Caruso's day science has really entered the picture and promises far more spectacular feats than the breaking of a wine glass. Between the two world wars scientific effort both here and abroad was devoted primarily to the study of sound generators themselves and to the particular field of underwater sound equipment, known since the last war as Sonar. Experiments in this field showed that the best results were obtained with sound generators which operated at frequencies above the range audible to the human ear—hence the name "supersonics."

As a direct result not only of the technological advances in supersonic equipment during the war but also as a consequence of its limited use to marine service, private agencies began to investigate the possibilities of new applications for these supersonic devices. Notable among the new uses are the curdling of milk and the detection of flaws in steel castings, but these direct uses have only scratched the surface of possible applications of supersonic energy.

THE EXISTENCE of another avenue of investigation has been indicated by cases like two recorded by C. W. Porter. In the first a chemist working in the field of a supersonic generator temporarily lost his sense of balance, while in the second a girl who was an expert at mental computation lost this faculty

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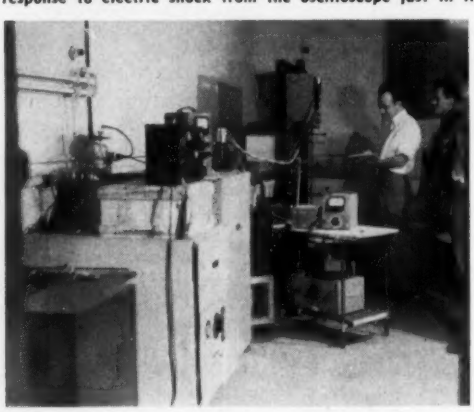
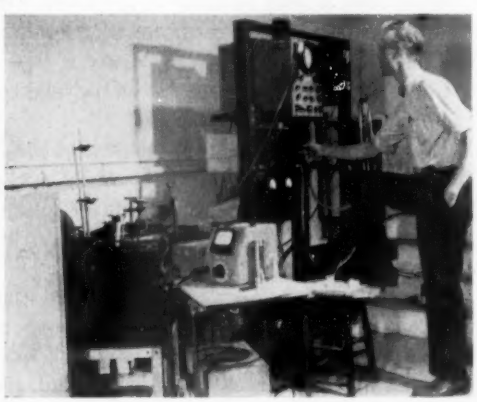
Fig. 2. (Left) Black tank near left of photograph is where piezo-electric crystal and nerve holder are located. Tank is lined with sound absorbent material. The man is observing the oscilloscope record of nerve response.

Fig. 3. (Right) Power tank on left partly hides tank in which crystal is operating. Observers are taking the record of nerve response to electric shock from the oscilloscope just in front of them.





How One Teacher Does It

Some Techniques Presented by

DR. PAUL BRANDWEIN

Forest Hills High School
Forest Hills, New York

Arthur Lazarus is a fine teacher of physics at Forest Hills High School. He is a splendid demonstrator. I have asked him to share some of his experiences with other teachers.

In the next two issues, in this column, he will do a rather complete job on the topic "Atmospheric Pressure."

Won't you share your experience with others in "HOW ONE TEACHER DOES IT"?—Paul F. Brandwein.

I SUPPOSE there must be a hundred demonstrations teachers have used to teach atmospheric pressure. About three or four are standard in general science. When I reach the topic in physics, I feel that teaching it anew is not necessary and that a little review is all that is needed. In order to make the review a little more interesting I try to avoid repeating the demonstrations that are usually shown in general science and introduce several different varieties which the pupil has not experienced. In my own catalog of about twenty atmospheric pressure demonstrations the first three or four will probably be recognized as ones that are usually presented in general science, and so in physics I take my choice of several of the remaining demonstrations. Herewith is my catalog.

1. *The Magdeburg hemispheres.* Be sure to grease the rims well.

2. *Evacuated gallon can.* Can may be evacuated with steam or with exhaust pump. Many pupils after having seen this demonstration conclude that all evacuated containers will collapse. A lively discussion of this idea may be supplemented with the display of an old radio tube or, better still, an old television tube which has a very high vacuum, yet is strong enough to resist the pressure of the atmosphere.

3. *Torricellian tube.* Tap tube continuously as it is being filled with mercury in order to expel trapped air bubbles. Use a deep dish as a reservoir in order to demonstrate how raising or lowering dish affects the mercury level in the barometer tube. Using two ringstands as supports mount a meter stick horizontally at the level of the mercury in the tube. Gently rock the tube back and forth. The surface of mercury will remain at the same level as the meter stick. Some teachers equip the lower end of the barometer tube with a two-hole rubber stopper, inserting a glass elbow bend in the other hole, and using as a reservoir a bottle into which the stopper fits snugly. Blowing or sucking on the elbow bend raises or lowers the mercury level in the tube. An added variation is to fill the barometer tube with colored water and repeat the above demonstrations.

4. *Evacuated tube immersed in mercury.* Immerse one end of a three-foot piece of glass tubing in a jar of mercury. Evacuate the other end with a simple air-pump. Discuss the possibility of the mercury overflowing the tube and flooding the pump.

5. *Evacuated bladder glass.* With a rubber band secure a piece of rubber sheeting over the hole in a bladder glass. Grease the bottom rim of the glass, place on pump plate, and evacuate with simple air pump. When students say the rubber sheet is sucked or pulled in, repeat experiment with greased square of glass placed over rubber sheet. Be sure no air is trapped between the rubber and the glass. Evacuate the bladder glass again. The rubber sheet is not sucked in. Slide off the glass square. Atmospheric pressure will push the rubber sheet in.

6. *Suction cup demonstration.* Press rubber suction cup against the inside of a bell jar. Then evacuate the bell jar until the suction cup falls off.

7. *Syringe demonstration.* Use a large rubber-bulb-type syringe, such as the hydrometer syringe used to test storage batteries. With it draw up some colored water from a completely filled small-mouthed bottle. Repeat, after first squeezing bulb and then ramming lower end of the syringe against the mouth of the bottle, thus excluding the atmosphere. The syringe will not fill up.

8. *Glass straw demonstration.* Through one of the holes of a two-hole rubber stopper, insert a two or three foot piece of glass tubing

to be used as a straw. Fill a Florence flask with water to the very top, insert stopper with straw, cover open hole with finger, and challenge a student to drink. After initial failure, remove finger from hole. For realism, a bottle of orange drink or other uncarbonated beverage may be substituted for the Florence flask.

9. *Breaking a ruler with the aid of atmospheric pressure.* Place a foot ruler on the table top with five inches of it overhanging at the edge. Cover the seven inches of the ruler on the table with a complete regular-sized daily newspaper folded into quarters in the usual manner. Strike the protruding end of the ruler a smart blow with the fist. The ruler will break as the atmosphere pressing down on the newspaper hinders ruler from moving. To demonstrate that it is the pressure of the atmosphere on the paper that is responsible for the result, repeat using a similar ruler and the same paper rolled or folded into a smaller area.

10. *Evacuated thistle tube.* With a rubber band fasten a sheet of rubber over a thistle tube. Evacuate the air. Point thistle tube in all directions to show that the atmosphere exerts pressure in all directions. This is a good sequel to the bladder glass demonstration.

11. *Leaky test tube.* Make a small hole in the bottom of a test tube. In advance of the demonstration fill the test tube with water and stopper it securely. Hand it to a student and have him open it on some pretext. Water dribbles out as soon as stopper is removed and stops when stopper is replaced. Hole is made by heating the bottom of the test tube in Bunsen burner and drawing it out with a piece of glass tubing as soon as the test tube starts to soften.

12. *Test tube that falls up.* Obtain two test tubes, one of which fits loosely inside the other. Half fill the larger test tube with water and insert smaller test tube half way. Invert the test tubes, and, as the water drips out between them, the atmosphere will force the smaller one to move upward.

13. *Inverted hydrometer cylinder of water with card.* This is a variation of the inverted glass of water trick. Before doing this one, however, canvass the opinion of the class as to whether such a long cylinder as the one about to be used will work successfully. Repeat, holding the cylinder sideways. Do not stray far away from the sink with this one. Try it again using the cylinder only half full of water this time.

14. *Inverted small-mouthed bottle of water.* Fill a small-mouthed bottle with water. Mouth should be about one quarter inch in diameter. Many perfume bottles will do. Slowly invert bottle over a pupil's head. The atmosphere with the aid of surface tension keeps the water from pouring. However, a good shake will get the water out.

15. *Condensed milk can.* Obtain a used condensed milk can that has two small holes in it. Fill the can with water. Place the finger over one hole and attempt to pour the water from the other. If the holes are small enough, you will be unsuccessful. Then remove the finger from the hole, and the water will flow. A flask fitted with a two-hole rubber stopper may be substituted for the can.

16. *Cylindrical bandage box demonstration.* Some boxes come over a foot long, although size is not important. They consist of a cardboard cylinder open at both ends each of which is fitted with a long cylindrical cover. The covers meet at the middle of the box. Pulling one cover off fast produces a pop as the atmosphere rushes in. A variation is to use a sheet of rubber as a cover for one end, fastening it with a rubber band, and rapidly pull the cover off the other end. The rubber sheet will be forced in by the atmosphere. This demonstration has also been found very useful in explaining Boyle's Law.

17. *Wet glass plates.* Wet two small glass squares with water. They stick together. Place them in a bell jar and evacuate. Plates fall apart.

18. *Rising cork demonstration.* Make a slit in a cork disc and in it stand a safety match head up. Float the cork in a dish of water. Ignite the match and place an inverted Tumbler over it. The water will rise in the tumbler. There are many variations of this demonstration in which the partial vacuum in the tumbler is produced in different ways.

19. *Drinking pan for chickens.* Fill a large gas bottle with water. Place over the mouth an inverted high-walled glass dish. Hold dish

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News and Announcements

STATE PHYSICS DAY INITIATED IN NEW JERSEY

The inauguration of the First Annual "State Physics Day" in New Jersey was held on Saturday, March 25, 1950, on the campus of the Colleges for Men at Rutgers University, New Brunswick.

This activity, the result of two State organizations uniting their efforts toward a worthwhile objective, was organized by Dr. Frank G. Dunnington, chairman of the Department of Physics at the State University, and Mr. Lee R. Yothers, head of the Rahway High School Science Department and president of the New Jersey Science Teachers' Association, assisted by the staff and officers of the two sponsoring organizations.

The purpose of State Physics Day is to discover New Jersey's high school youth who have outstanding talent in the field of physics, and to encourage the development of this ability.

WRITE FOR IT

General Electric, Schenectady, New York, announces that its latest cartoon narrative, *Story of Light*, is available to teachers in any quantity desired. A new publication, *Thunderbolts in Harness*, is off the press, and a publication to complement that story will be off the press in a few days. Entitled "Steinmetz: Latter-day Vulcan," it is being printed in sufficient quantity to meet teachers' needs.

W. M. Welch Manufacturing Company has just published a chart on the Thorium, Neptunium, Uranium and Actinium Series. This chart was originated by Dr. Herta R. Leng of Rennsalaer Polytechnic Institute. The chart will be sent free of charge on request to interested scientists. W. M. Welch Manufacturing Company, 1515 Sedgwick Street, Chicago 10, Illinois.

NEW SCHOOL MICROSCOPES

Science teachers will be glad to know that manufacturers have become interested in the need for good, low-priced instruments. The Testa Manufacturing Company, for instance, is offering two instruments, Model F (illustrated) and Model G-3 which serve the specific purposes of science and biology classes.

The two microscopes are full-size standard laboratory instruments, equipped with lenses powerful and precise enough to resolve such fine details as striae in muscles, chromosomes and structure of Pleurosigma diatom. Yet, they can be set to low magnifications to show whole mounts of larger specimens.

The teacher's manual supplied with the instrument should prove an effective guide to preparation of specimens, experiments with polarized light, microprojection and classroom sketching.

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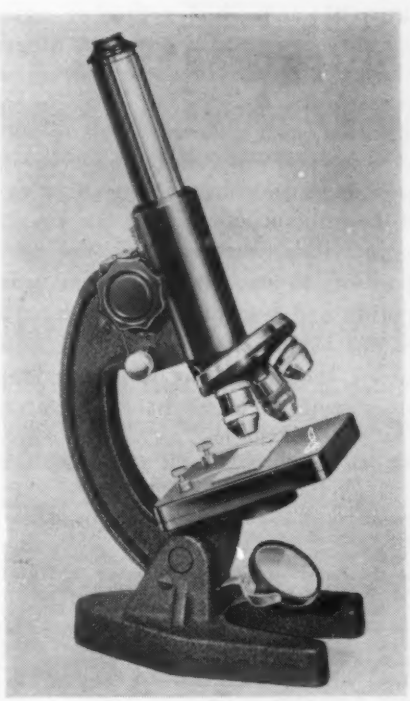

INDIVIDUAL LABORATORY WORK

Continued from Page 64

these: (1) the irritation felt by administrators toward the continually recurring problem of fitting the seven-period program into their high-school schedules, especially in those schools in which the laboratory was separate from the classroom; (2) the dissatisfaction of discerning teachers of science over the difficult, if not impossible, task of integrating effectively the laboratory work with the class discussions, when the laboratory work had to be done at certain fixed periods; (3) the evidence of several investigations,[1] [2] [3] [4] which cast doubt upon the assumed advantages of long, over short, periods and of double, over single, periods for science classes; and (4) the strongly growing opposition by teachers of other subjects than science, toward the "favoritism" shown science courses in having an allotted seven periods per week, which these teachers insisted could be provided with equal or greater justification for their own courses.

Let us take a sober and realistic view of the situation as it now exists. The summary of trends here briefly presented seems conclusively to indicate that, for at least half a century, the individual method of performing laboratory experiments has been progressively losing ground. In some courses and in many schools, it is facing complete elimination. That such a development is not justified is amply revealed by unquestioned research evidence. But neither this evidence nor the militant support for the retention of the individual method and the persistent opposition to its reduction from university scientists and leaders in the teaching of science has halted, if indeed it has appreciably retarded, the trend away from individual laboratory work in high-school science courses. To be sure, in the best secondary schools, individual laboratory work has still an important place; but ironically, this fact has partly obscured the general continuing reduction in individual pupil experimentation. It would seem fantastic to assume that the individual method will ever be wholly eliminated from secondary-school science. Nevertheless it is disturbingly evident that a large proportion of boys and girls in science classes now, are being deprived, and a larger percentage in the future seem likely to be deprived, of this essential training.

THE FORTY-SIXTH Yearbook Committee, N.S.S.E., stanchly champions the cause of retaining the individual method. It states:

Since experimentation involves 'learning by doing' there can be no substitute for it. Pupil experimentation is an essential part of good science education. In every course of science offered at any level, therefore, opportunities should be provided for the pupils to perform experiments.[1]

The Committee recognizes that "A trend is unmistakably developing throughout the country toward eliminating the double-laboratory period in senior high school science courses," but states that

Shifting from seven to five periods per week neither necessitates nor justifies the elimination of all individual pupil experimentation, as has sometimes been contended. To substitute demonstrations, discussions, or other activities for such experimentation, with the excuse that single periods provide insufficient time for individual laboratory work, is indefensible.[2]

The Committee then reaffirms in substance[1] the practical plan recommended fifteen years earlier by the Thirty-first Yearbook Committee of the same organization, for securing optimal results through a combination of the individual and the demonstration method.

In recapitulation, then, the weight of both research evidence and authoritative opinion, imposes a mandate to retain individual laboratory work in *every* course. The teachers of science who accept this mandate can and will find, in even the most meagerly equipped

1—Victor A. Sugar, *An Investigation of the Relative Values of Single Laboratory Periods and Double Laboratory Periods in High-school Chemistry.* Unpublished study, University of Michigan, 1928.

2—George E. Denman and Thomas J. Kirby, "The Length of the Period and Pupil Achievement in High School." *The School Review* XLI (April, 1933), 284-289.

3—L. W. Applegarth, "Comparison of the Effectiveness of the Single Laboratory Period and the Double Laboratory Period in High-school Chemistry." *School Science and Mathematics,* XXXV (June, 1935), 627-633.

4—Henry W. Duel, "The Effects of a Shortened Class Period upon Achievement in High-school Physics." *Science Education,* XX (October, 1936), 157-159.

1—*Science Education in American Schools.* Forty-sixth Yearbook, N.S.S.E. Part I. P. 53.

2—Ibid, p. 44.

1—Ibid, pp. 53-54.

Continued on Page 84

Science in all its forms, has consequences, direct and powerful, for human society. Recognizing this, Silver Burdett science texts emphasize the social implications of science, organizing basic subject matter around problem areas having significance for young people in their everyday living.

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LABORATORY WORK

Continued from Page 82

schools, some means for individual experimenting. In order to implement such experimenting in schools in which double periods either cannot or will not be provided, teachers and research investigators must devise for every course, worthwhile experiments which can be effectively performed by pupils within the time limitations of a single period. Teachers who succeed in inventing successful experiments of this sort should be encouraged to report them promptly in the several journals devoted to science education. More investigators should be encouraged to join the limited number now engaged in determining practicable lists of such experiments. The results of such research should be promptly reported. No doubt the Federal Security Agency's staff of experts in the teaching of science, who are continually demonstrating their competence and effectiveness in disseminating important research findings and other materials through their series of special publications, will employ their unique facilities in making these important contributions generally available.

ONE further consideration seems logical for inclusion in a discussion of laboratory teaching. Extensive observations of laboratory practices in secondary schools reveal that many teachers consider that the pupils are doing individual laboratory work when the latter work in pairs. A smaller but still substantial number of other teachers consider that they are conducting individual laboratory work whenever groups of pupils, but not the teacher, are performing experiments, even though the pupils in these groups number three, four, or more (in one observed chemistry class, twelve!). Relative to these practices the Forty-sixth Yearbook Committee states, "Individual laboratory work can mean only experiments performed by a single pupil."[1]

The results of Carpenter's investigation[2] indicate that pupils gain less from working in pairs than from working individually. In har-

1—Ibid. p. 54.
2—W. W. Carpenter, *Certain Phases of the Administration of High-school Chemistry*. New York: Teachers College, Columbia University, Bureau of Publications, 1925.

Continued on Page 86

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LABORATORY WORK

Continued from Page 84

mony with these findings and other indications, the Yearbook Committee recognizes that the expense of providing individual equipment for all experiments which the pupils perform is not justified, and that pupils need to work in pairs in that relatively small number of experiments in which one person alone cannot carry on both the needed manipulations and at the same time make the observations. Relative to the practice of having pupils carry on these experiments in groups, the Committee cautions that when "more than two pupils attempt to perform an experiment with one set of apparatus, the benefits derived by all but one or perhaps two members of the group will almost inevitably be small."[3]

3—Ibid, p. 54.

PRESIDENT'S PAGE

Continued from Page 65

ing, or application of the methods of science to the problems of daily living.

As we select our textbooks, let us look for emphasis on these significant outcomes of general education toward which functional science teaching has much to contribute. Let us hope that we will see more of such emphases in science books in the years to come.

NEWS AND NOTES

Continued from Page 67

Dr. Gjelsvik is making a five-months tour of the United States for a special study of various aspects of education, with emphasis on "problems of practical teaching of physics, mathematics, and astronomy." Some twenty NSTA members are serving as hosts and guides to Dr. Gjelsvik during his stop-overs in various cities. Following one month in California and two weeks in Washington and Oregon, he will return to the East by way of the Dakotas with a stop-over to visit some "American cousins." After a week's trip to Knoxville, Tennessee, to visit the University of Tennessee, TVA, Oak Ridge, and the Smoky Mountains, he will return to Washington, D. C., and drive with Bob Carleton to St. Louis for the summer meetings of NSTA and the NEA Delegate Assembly.

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St. Louis and the 1950 Summer Meeting

The annual summer meeting of NSTA will be held July 1-3 just ahead of the NEA Delegate Assembly. St. Louis is the city and it is expected that all NSTA sessions will be held in the DeSoto Hotel. Although details and names of speakers are not yet available, Norman Jones and a local committee representing NSTA and the Missouri Science Teachers Association, host for the occasion, are developing a program which will be well worth anyone's time to attend. Centrally located and strongly supported by the Missouri STA, the 1950 meeting promises to be one of the best attended of all NSTA summer meetings. The program is shaping up along these lines:

Saturday, July 1—Morning and afternoon sessions of the Board of Directors (All sessions are "open" and members are invited and urged to attend.)

—Evening open for meetings of committees.

Sunday, July 2—Morning session of Board of Directors.

—Afternoon and evening: trip to St. Louis zoological park; box supper and attendance at the open-air civic opera.

Monday, July 3—Morning and afternoon professional sessions with emphasis on "practical ideas and promising practices for teaching science today"; registration at 9:30 A. M. followed by five or six papers; tentative titles:

"Better High School Preparation of Students for College Science"

"Report of the Illinois Curriculum Committee for the Teaching of Health in the Secondary School"

"Teaching Earth Science in Elementary and Secondary Schools"

"Emphasizing Safety Thru Elementary Science"

"Field Trips and Excursions in the Teaching of Biological Science"

ELECTRONICS

Continued from Page 69

for the distribution of the high potential dc supply. A third bus (not shown) for screen potentials might be added. In addition, the assembly panel of Fig. 1 bears a 110 volt ac convenience outlet, a pilot lamp (connected across the filament supply) and a dc voltmeter of 100 ohms-per-volt sensitivity. Multi-

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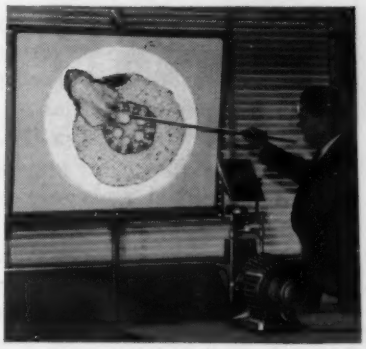

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pliers can be inserted into the voltmeter circuit to give it any desired dc range.

Summary of Construction Features

In spite of the simplicity of this general arrangement of plaques on a vertical panel—or perhaps *because* of its simplicity, it offers many important advantages. For example:

Except for the snap fasteners and the electronic components themselves, only common materials such as wood, nails, wire, and paint are needed. But for the optional use of a drill press, no special tools or construction skills are required.

The plaques are large enough to be seen by fair-sized groups, yet small enough to permit the assembly of a moderately complex circuit on a medium-sized assembly panel.

The 2 in. spacing pattern of supporting nails makes it possible to mount any plaque within one inch of the desired position.

The square pattern of nails and holes permits mounting of the plaques in any one of four attitudes. While this may at first seem like a trifling matter, experience has shown that in complicated circuits, particularly at radio-frequencies, this flexibility of pattern and compactness of components is of the utmost importance.

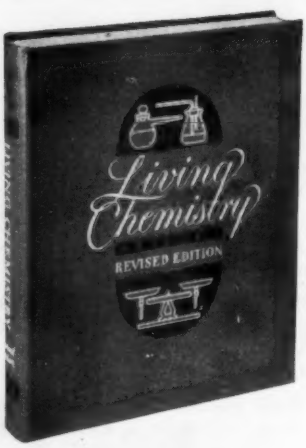
Plaques can be mounted either on a vertical panel or spread on a laboratory bench. Indeed, many applications find a circuit developing on a vertical panel, and literally "overflowing" onto a table. It is possible to rotate the assembly panel 90 degrees if the shape of the circuit being constructed makes that desirable.

Electrical connections can be made and broken with a maximum of ease and a minimum of delay.

Many conductors can be connected to a single point in the circuit.

Finally, it must be emphasized that this equipment is economical both from the point of view of financial outlay and requisite skills. Furthermore, the equipment is highly useful even before the collection of component plaques is complete. All this makes the construction of this kind of teaching equipment an ideal learning-by-building project for a class in electronics or electricity, physical science or industrial arts.

New!



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Continued from Page 77

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HYDROGEN CHLORIDE

Continued from Page 74

takes place. The similar reaction of HCl with ammonia NH_3 is familiar.

$$H{:}Cl + \underset{\cdot\cdot\ H}{\overset{\cdot\cdot\ H}{H{:}N{:}}} \rightarrow \left\{ \underset{\cdot\cdot\ H}{\overset{\cdot\cdot\ H}{H{:}N{:}H}} \right\}^{+} + Cl^{-}$$

A like reaction takes place with water but, unlike ammonium chloride, hydronium chloride is not stable at room temperature and cannot be isolated from solution by merely evaporating the water.

$$H{:}Cl + \underset{\cdot\cdot\ H}{\overset{\cdot\cdot}{:O{:}H}} \rightarrow \left\{ \underset{\cdot\cdot\ H}{\overset{\cdot\cdot}{H{:}O{:}H}} \right\}^{+} + Cl^{-}$$

Dr. Pauling[2] points out support for this view by citing the fact that hydronium perchlorate $(H_3O)^+$ $(ClO_4)^-$ and hydronium nitrate $(H_3O)^+$ $(NO_3)^-$ are known substances that may be crystallized from solutions. The following hydrates of hydrogen chloride are claimed to exist: $HCl \cdot H_2O$, 1.48 g per ml, melting point −15.35°C; $HCl \cdot 2H_2O$, 1.46 g per ml, melting point −17.7°C; and $HCl \cdot 3H_2O$, melting point −24.4° C. All are colorless solids and melt to form solutions of HCl in water of the same composition. We may consider, thus, that hydronium chloride and its hydrates exist, but are stable only at lower temperatures.

IT IS WELL known that many of the properties that we usually associate with acids are not exhibited by hydrogen chloride unless water is present. These properties undoubtedly are more accurately to be ascribed to the presence of the hydronium ion, H_3O^+. We can sum up by saying that dilute aqueous hydrogen chloride solutions contain water molecules, hydronium ions, chloride ions, and relatively few hydrogen chloride molecules. The ions are separated by water which has a high dielectric constant and reduces the forces of attraction between them. In more concentrated solutions the number of HCl molecules increases and can be detected in the vapor arising from the solution.

Facts such as those given above have

2—*loc. cit.*, p. 211.

pointed out the need for a broader concept of acids and bases. One of the most useful definitions is that offered by Dr. Bronsted in which an acid is considered to be any molecule or ionic species that can yield a proton, H^+, and a base is a proton acceptor. An extended discussion of this and other theories of acids and bases will be found in the two little volumes ACIDS AND BASES and MORE ACIDS AND BASES, published by the Journal of Chemical Education, and available from the Mack Printing Company, Easton, Pa.[3]

3—For much of the new data presented, the reader is referred to *Engineering Chemistry, 35,* p. 258, June, 1948, *"HCl Absorption;" ibid., 36,* p .243, Feb. 1949, *"Hydrochloric Acid versus Construction Materials"; ibid., 36,* p. 305, April, 1949, *"Commodity Survey—Hydrochloric Acid."*

SUPERSONICS

Continued from Page 78

during exposure to a supersonic field and regained it when the field was removed. These and other cases definitely pointed toward the investigation of the biological effect of supersonic energy.

The University of Illinois under contract to the Office of Naval Research is investigating this particular phase of supersonics. The present job of the group conducting this research is (1) to determine the stimulative effects of a supersonic field on a single nerve, and (2) to determine the effect of varying intensities of a supersonic field on the electrical conductivity of a nerve. To accomplish these jobs a special holder has been designed which permits the application of an electrical impulse to the nerve while the nerve is suspended in a sound field. During actual tests, the holder and nerve are suspended in a sound-transparent case which is filled with Ringer solution, and the whole assembly then mounted in the supersonic field.

The sound field is generated by the use of a quartz crystal. Through a primary and secondary coil set-up, voltage is stepped up so that approximately 0 to 10,000 volts are available at the crystal. An oscillator is now introduced into the system so oscillating voltage may be applied to the crystal. As this oscillating voltage is applied, the crystal responds by pulsating like an accordian, that, is expanding and contracting in frequency with the oscil-

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lator. The crystal as a result sends out energy in the form of minute waves.

WHEN complete tests have been made on the nerve, the group anticipates and hopes to show that a low-intensity supersonic field will slightly decrease the electrical conductivity, while a medium-intensity field will partly reduce conduction, and a high-intensity field will totally block conduction. If it is found that a high-intensity field does completely block nerve conduction, it is entirely conceivable that when focused, by the use of a parabolic mirror, it could replace some present applications of anesthetics without their adverse after-effects.

Additional tests are planned to determine the effect on tissue. The two cases mentioned before, and the preliminary work so far, seem to indicate that a low-intensity field will have no deleterious effect, whereas an extremely high-intensity field may actually destroy the tissue.

Further speculation brings up the possibility of using an extremely high-intensity, focused field for the intentional destruction of diseased tissue without the dangers of surgical exposure. An operation like a prefrontal lobotomy, in which diseased brain tissue is removed, may become unnecessary if this technique can be perfected. Similarly the fight against cancer will get a big boost provided a sufficiently well focused supersonic field can be developed to destroy the cancerous tissue but leave the surrounding tissue unharmed and unexposed.

Certainly the promised uses of supersonic energy are no less spectacular feats than that of Caruso's breaking the wine glass, and of far greater benefit to human knowledge and endeavor.

HUMAN HEREDITY

Continued from Page 72

14—Stern, *Science*. 110 (1949) p. 203.

15—Stern, *Principles of Human Genetics*. p. 55.

16—Davis, W. Allison, and Robert J. Havighurst, *The Measurement of Mental Systems* (Can Intelligence Be Measured?) *Scientific Monthly*, 66 (April, 1948) pp. 301-316. Davis, W. Allison, *Social Class Influence upon Learning*. (Cambridge, Mass., 1948).

17—See for example, Penrose, Lionel, *The Biology of the Mental Defect*. (London, 1949), esp. Chapter VI.

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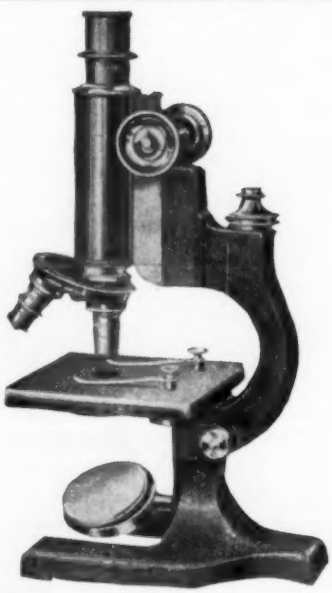

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HOW ONE TEACHER DOES IT

Continued from Page 80

securely against bottle and then invert both. Raise bottle about one half inch above dish so that water flows into it. Bottle should be held at this level with a ringstand. Water flows out of bottle only when chickens drink enough to cause water level in dish to sink below mouth of bottle. Thus the water in the bottle is kept clean until drunk. A large syringe will substitute for a thirsty chicken. Of course a real drinking pan may be bought from any mail order house.

20. *Inflating a sealed balloon.* Seal the opening of an uninflated balloon with a rubber band. Place balloon in a bell jar and evacuate the atmosphere from it. Air trapped inside balloon will inflate it as the pressure of the atmosphere around the balloon is removed.

21. *Making a magnifying glass from an old electric light bulb.* Immerse a clear electric light bulb that has a tip in a basin of water. With a scissors cut or break off the tip. The atmosphere will push the water into the bulb. It may now be used as a magnifying glass.

22. *Coffee carton demonstration.* Obtain from a restaurant two cartons used for coffee to be taken out. Be sure that the cover of one has an unclogged hole in it, and the other a hole covered with Scotch tape. At the beginning of the period fill both containers to the brim with hot water and tightly cover each. The water should be hot in order to drive out any air that tends to remain in the container. Later on in the period have pupils try to open them. The cap with the open hole comes off easily, but not so the one with the clogged hole, thanks to the pressure of the atmosphere.

The purpose of the foregoing list of demonstrations is to show that (1) there is no such thing as suction, (2) the atmosphere exerts pressure, and (3) this pressure is exerted in all directions. The list is by no means complete. There are many other demonstrations of atmospheric pressure, such as pumps and the siphon, also those connected with Bernoulli's Principle, but the author has classified those as applications rather than as basic demonstrations. The author will be glad to hear from those who have additional ideas to enrich the teaching of this topic.

Book Shelf

DISCOVERY PROBLEMS IN PHYSICS WITH NUCLEAR PHYSICS. Revised edition. Hallie F. Turner, Eastside High School, Paterson, N. J. College Entrance Book Company, New York, 1950. $1.00.

Discovery Problems in Physics is a complete teaching program for a modern course in high school physics. Its purpose is to provide the teacher and student with text assignments, lesson outlines in exercise form, laboratory experiment sheets, homework drill, frequent reviews and a testing program. A booklet of film guide lesson sheets and two equivalent sets of tests will be available soon.

NEW DISCOVERY PROBLEMS IN BIOLOGY. Grace Bagby, Harold U. Cope, C. S. Hann, and Mabel B. Stoddard. College Entrance Book Company, New York, 1950. 355 pp. $1.00.

New Discovery Problems in Biology retains all of the features which made the previous edition popular. A reorganization of content, the complete rewriting of the most important units, the improvement of many of the illustrations along with use of color, and the introduction of new topics have combined to produce a study guide which is even easier to teach from, and more rewarding to study from. Filmguides and two equivalent sets of tests are in preparation and will be available soon.

TELEVISION SIMPLIFIED. Milton S. Kiver. D. Van Nostrand Co., New York, 1950. 608 pp. $6.50.

This profusely illustrated third edition will be a welcome text for those who require a nontecnical treatment of television. An elementary knowledge of radio is all that is prerequisite to an understanding of the text. It includes a chapter on frequency modulation and a new chapter which discusses the recently devised Intercarrier Sound Television system. A color television chapter includes the new CBS, RCA and CTI systems, and another chapter outlines the causes of and gives remedies for common television receiver troubles.

J. S.

BIOLOGY. Wheat and Fitzpatrick. American Book Co., New York, 1949. 596 pp. $3.40.

This is a new general biology text by the well known authors. It is attractively well illustrated, and its unit organization makes it adaptable to modification for a particular course of study. Applications and inferences are often made in reference to the personal interests of boys and girls. In addition to questions and exercises, chapters are accompanied by suggestions of "things to do."

J. S.

WORKBOOK TO ACCOMPANY CURTIS AND URBAN'S BIOLOGY IN DAILY LIFE. Francis D. Curtis, University of Michigan. Ginn and Company, 1949. 169 pp. 88 cents.

This workbook written to accompany Curtis and Urban's Biology in Daily Life is organized in units that may well serve as the basis of a course using a number of texts. The problems deal with vital life matters and meet the needs of youth in this field.

The book provides many drawings but requires others to be made by the students that are less difficult. Space is provided for writing in complete statements in answering questions related to the experiments. Other types of exercises are arranged for ease in checking.

DISCOVERY PROBLEMS IN GENERAL SCIENCE. Theodore E. Eckert, Cornell University. College Entrance Book Company, 1950. 284 pp. Illus. 90 cents, net.

This book provides an abundance of exercises designed to cause students to think through the science problems usually chosen for the ninth grade. There are many simple demonstrations that require a minimum of equipment and that can be performed quickly. The book attempts to meet the needs of students when apparatus is not available by providing exercises with diagrams of apparatus requiring completion. Color used in illustrations not only increases interest, but adds to the clarity of the explanation.

The units are broken up into sections that lend themselves to adaptation to many different plans of course organization. Page references to a number of texts are provided with each unit.

A recent innovation is a film guide that provides learning exercises based on films that are suited to study units. The films listed are from Coronet and Encyclopaedia Brittanica Films. The guide is supplied at no additional cost.

MODERN BASIC PHYSICS—A STUDY GUIDE AND MANUAL. William F. Einbecker, Head of Science Department, Highland Park High School, Highland Park, Illinois; and Alfred M. Clem, Instructor of Physics, J. Sterling Morton High School and Junior College, Cicero, Illinois. Mentzer, Bush and Company, Chicago, 1949. 352 pp.

This physics study guide is both a study guide and laboratory manual. This manual shows the students what to do and how to do it. Problems, questions, drill material, projects, and experiments require pupils to do some thinking and research work as well as studying. The guide was worked out by two classroom teachers—one in a highly residential section and the other one in a semi-industrial section.

Heavy lines, special shading, labeling, two colors, and many other devices have been used to make the illustrations play a real part in the learning process. The supplementary material outlines some of the most modern thought in physics such as the Einstein Theory of Relativity and the Nature of Atomic Energy.

THE ALCHEMISTS—FOUNDERS OF MODERN CHEMISTRY. F. Shrewood Taylor, Curator of the Museum of the History of Science, Oxford. Henry Schumann, Inc., New York, 1949. 246 pp. 15x21.5 cm. $4.00.

Until now the reader seeking a clear account of alchemy and its contributions to man's achievements has found little or nothing which will give him this story. But here, in *The Alchemists: Founders of Modern Chemistry*, another addition to the Life of Science Library, Dr. Taylor has provided for the first time a wealth of material which explores this fascinating subject fully and resolves its apparent contradictions.

This book draws upon the whole body of alchemical writings, including many unpublished manuscripts. A particularly unusual feature is the chapter on Chinese alchemy.

Containing nothing that cannot be appreciated by those without specialized training, this volume is intended primarily for the informed layman. The author has drawn a compelling picture of alchemy's age-long quest and of strange, sometimes moving figures who toiled and hoped and crystallized their experience in the poetic and artistic imagery of the alchemical texts.

JAMES WATT AND THE HISTORY OF STEAM POWER. Ivor B. Hart. Henry Schuman, Inc., New York, 1949. 250 pp. 15x21.5 cm. $4.00.

This addition to *The Life of Science Library* provides a comprehensive picture of a great 18th century Scotch engineer, and his contribution to the history of human progress. Dr. Hart explores the social and economic needs which gave impetus to Watt's great engineering achievements and provides a very human portrait of Watt and the men to whom he was indebted. No one can have a complete understanding of technological evolution or of industrial progress in the 18th and 19th centuries without knowledge of Watt, of the society in which he worked, and of his predecessors. Dr. Hart imparts this knowledge clearly, compactly, and very readably, for both the student and the general reader. In writing this story the author draws freely on his wealth of historical and scientific knowledge. For more than twenty years, he has been engaged in government education work and was honorary research assistant and lecturer in the Department of History and Method of Science at University College, London University.

LABORATORY OUTLINES AND NOTEBOOK FOR ORGANIC CHEMISTRY. Cecil E. Boord, Professor of Organic Chemistry, Ohio State University; Wallace R. Brode, Associate Director National Bureau of Standards; and Roy G. Bossert, Associate Professor of Chemistry, Ohio Wesleyan University. John Wiley and Sons, Inc., New York. 282 pp. 28x20.5 cm. $3.00.

In the preparation of the second edition of this manual the authors have retained the approach and basic form of the first edition. The rapid advance in practical organic chemistry since the first edition has called for the inclusion of experiments which study a number of new and familiar commercial preparations. In view of these advances exercises dealing with synthetic rubber, hydrolysis of nylon and others are included. There has been an increase in the number of exercises dealing with aliphatic compounds so as to keep the lecture and laboratory work closely parallel. The individual exercises are designed to enable the instructor to handle a relatively large number of students and to spend the major portion of his time in oral quiz and laboratory supervision.

A LABORATORY BOOK OF ELEMENTARY ORGANIC CHEMISTRY, Third Edition. Alexander Lowy, Late Professor of Organic Chemistry and Wilmer E. Baldwin, Associate Professor of Organic Chemistry, University of Pittsburgh. John Wiley and Sons, Inc., New York, 1949. 186 pp. 22.5x28 cm.

The experiments outlined in this book constitute the laboratory part of the elementary course in organic chemistry as it is given at the University of Pittsburgh for students who take organic chemistry as a second or third chemistry course. The purposes of this book are to teach the technique of organic chemistry, to give methods of preparing organic compounds, and to study the properties of well-known members of the various classes of compounds. The more difficult experiments and operations are intentionally omitted.

Most of the experiments are divided into two parts. The first part gives the laboratory directions for preparations, properties, or tests. The second part, consisting solely of questions, is for the student's report. The illustrations and diagrams of industrial apparatus given here are included merely to show what equipment the chemical industries use to effect the same types of reactions as are conducted in the laboratory. In this third edition improved methods for several of the experiments have been introduced.

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PHYSICS—A BASIC SCIENCE. Elmer E. Burns, Teacher of Physics (Emeritus), Austin High School, Chicago; Frank L. Verwiebe, Research Physicist, Applied Physics Laboratory, The John Hopkins University; and Herbert C. Hazel, formerly Assistant Professor of Physics, Indiana University. D. Van Nostrand Company, Inc., New York, 1948. 674 pp. 15x23 cm. 500 illus.

The second edition of this standard physics offers a fresh approach to high school physics. The student is introduced to basic principles through ordinary activities—drinking soda through a straw, pushing a lawn mower, etc. There is constant emphasis upon the relation of physics to everyday life. New sections are included on atomic energy, radar, and jet propulsion. New treatment is given to the cathode ray tube, automobile generator, electrostatic machine, and counter tubes. The traditional content has been divided into twenty-five units, each subdivided into eighty short chapters of about six pages each. Each chapter covers one basic principle, and is a complete and efficient lesson assignment. At the end of each chapter are found student projects to be carried out at home. Chapters are followed by summary questions, general questions, and problems, graded for different ability levels. Separate workbook, laboratory manual, multiple choice tests, and teacher's guidebook are available.

COMPARATIVE ANATOMY. Leverett A. Adams, Professor of Zoology and Curator of the Museum of Natural History, University of Illinois; Samuel Eddy, Professor of Zoology, University of Minnesota. John Wiley and Sons, Inc., New York, 1949. 520 pp. 15.5x23 cm. $5.00.

Comparative Anatomy, designed for courses in vertebrate zoology or comparative anatomy, is a well-organized text on the undergraduate level. The book replaces an earlier work, *Introduction to the Vertebrates*. Sections that had been found inadequate in this earlier book have been expanded, and some major alterations in the classification of certain groups have been made. Recent discoveries and new viewpoints have been incorporated throughout the book. The book contains a 4-page bibliography, a detailed glossary, and a full index. Its numerous illustrations have been carefully selected and are well labelled.

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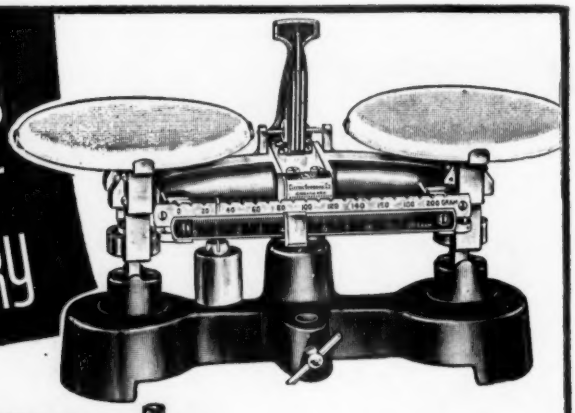

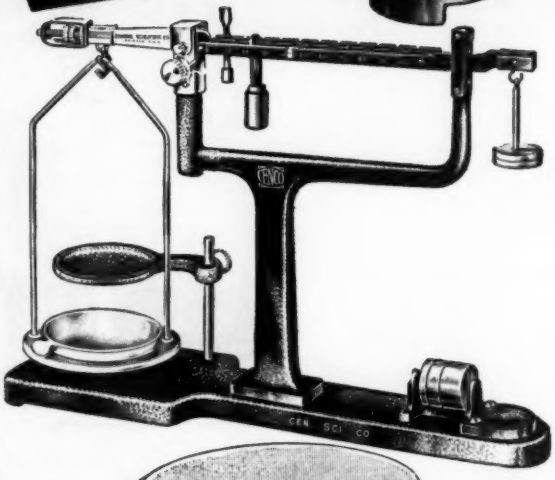

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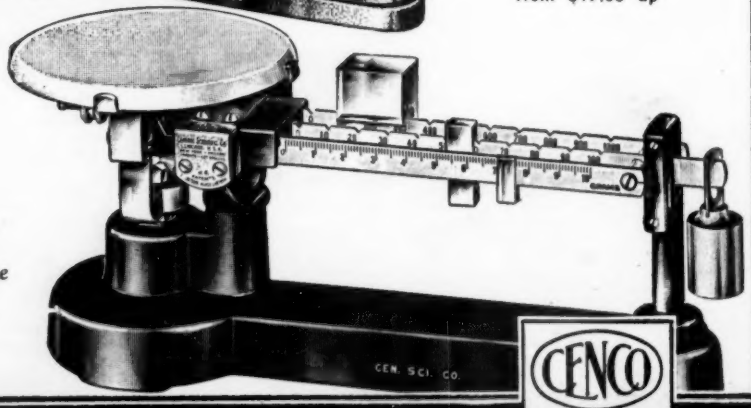

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